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SESSION 1942-43

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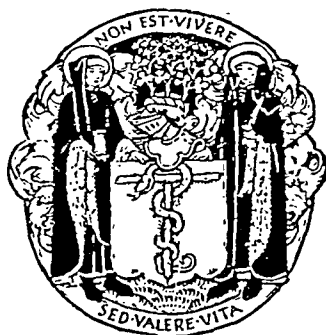
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## Section of Pathology

President—C. H. ANDREWES, M.D., F.R.S.

[October 6, 1942]

### Thoughts on the Origin of Influenza Epidemics [Abridged]

#### PRESIDENT'S ADDRESS

By C. H. ANDREWES, M.D., F.R.S.

INFLUENZA seems an appropriate subject for review at this time, for all of us must have at the back of our minds a fear lest a terrible pandemic may occur before the end of this war, as it did in 1918-1919. There is little doubt that an influenza epidemic which is well under way is spread by means of droplets and perhaps especially by minute droplet nuclei. In this paper, however, I am more concerned with what happens at the beginning of an outbreak and with the reasons why epidemics only afflict us at intervals.

Laboratory studies have been of two main types: first, the infection with virus from human sources of ferrets, of mice, and of chick embryos; second, the estimation in human sera of antibodies against the influenza virus, either by neutralization tests in mice, or on chick membranes, by complement fixation, or by the new agglutinin-inhibition test (Hirst, 1942). This latest test promises to be most valuable; it depends upon the fact that suspensions of influenza virus will agglutinate fowl red cells and also that this agglutination can be inhibited by specific antiviral sera.

#### I.—THE APPARENTLY DIVERSE ÆTIOLOGY OF INFLUENZA

Various infections of the upper respiratory tract are apt to be labelled "influenza" by doctors meeting with them. In the 1937 outbreak in this country, combined clinical and laboratory studies attempted to distinguish between epidemic influenza and a group of other diseases labelled for convenience "febrile catarrhs" (Stuart-Harris *et al.*, 1938). It seemed at that time to be a good generalization that the cases yielding virus were, on the whole, of sudden onset and had predominantly constitutional symptoms, while the others, the febrile catarrhs, were, on the whole, of more insidious onset and with catarrhal symptoms more in evidence. There were other clinical differences between the two groups. The distinctions were not sharp enough to permit diagnosis of individual cases, but they did apparently suffice to enable one to prophesy with some success whether a group of cases would or would not prove to be due to virus infection. In outbreaks in 1939 this clinical distinction seemed to break down (Stuart-Harris *et al.*, 1940). Numerous patients and groups of patients, satisfying the 1937 criteria for a diagnosis of epidemic influenza, yielded no evidence, on laboratory study, that the influenza virus was to blame. Then Francis and Magill (1940b) in America independently isolated from patients with clinical influenza a virus which resembled those recovered earlier in being pathogenic for ferrets and mice, but which was immunologically quite distinct. For more precise definition workers at the National Institute for Medical Research agreed with those working in the Rockefeller Foundation's laboratories in New York (Horsfall *et al.*, 1940) to refer to the virus isolated in 1933, and hitherto called epidemic influenza virus, as "Influenza A" virus. Francis' virus, which seems to be the same as Magill's, seemed naturally entitled to be called "Influenza B" virus. Since the viruses of yellow-fever, lymphocytic choriomeningitis, and others may cause influenza-like symptoms in man, some thought may be necessary before deciding when a newly recognized virus is to be

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apparently due to "Influenza A" virus, and virus was transmitted to ferrets from a high proportion of garglings tested. The only strain available from the 1933 outbreak was readily adapted to mice after passage through ferrets (Andrewes, Laidlaw and Smith, 1934) and in 1937 adaptation to the mouse was also fairly easy (Stuart-Harris *et al.*, 1938). The even years, 1934, 1936, 1938, 1940, 1942, have yielded almost no laboratory evidence of "Influenza A" prevalence in England; in the years 1935, 1939 and 1941 A-infection has been apparent, but not on a large scale. There was a big outbreak in 1929 before those of 1933 and 1937, so that it looked as though a four-year cycle of larger outbreaks had become temporarily established; but the small prevalence in 1941 broke the sequence. In 1935, strains from one localized outbreak in the Army infected ferrets and mice very readily; viruses from other localities did so less easily (Andrewes, Laidlaw and Smith, 1935). In the small A-prevalences of 1939 and 1941, it was more difficult than in previous years to establish strains of virus in the ferret, even from cases known to be "A" on serological grounds; it was also difficult to adapt viruses from ferret to mouse, more particularly in 1941 (Andrewes *et al.*, 1941). These variations from year to year are indicated in the table.

Findings from the U.S.A. agree on the whole with our own, though data are probably not strictly comparable; in particular it is hard to assess the relative importance of different American outbreaks. Here, there is apparently less difference between the recorded influenza prevalence in "A" years and other years; possibly "influenza B" is a more important disease in America or, perhaps, one should expect differences to be less sharp in a country of such vast area. Serological studies by the Rockefeller Foundation team indicate that in the years 1937, '39 and '41, the A-infections constituted respectively 84, 56 and 70% of the prevailing influenza. As in England, "Influenza A" was almost absent in the even years, but in the odd years there was less year-to-year fluctuation than in England in the ease with which A-infection could be demonstrated by laboratory tests; this may be related to the fact that A-prevalences have tended to occur simply every other year, not, as with us, every other year with an extraordinary emphasis on one year in four. American viruses were adapted to mice very easily in 1937, much less so in 1939. Data from Hungary (Taylor *et al.*, 1941), Australia (Burnet and Lush, 1940), Canada (Hare *et al.*, 1942), the West Indies and Argentina confirm that years with most influenza are years when A-virus is prevalent, but they do not reveal much about the variation in pathogenicity for ferrets and mice of the strains recovered in different years.

### III.—WHEREABOUTS OF INFLUENZA VIRUS BETWEEN EPIDEMICS

"Influenza A" is only prevalent in Britain every other year, and when it comes, it has recently almost confined its activities to the months of January, February and March. The virus has in a few instances been recovered from garglings of healthy persons during epidemics (Francis *et al.*, 1937), and there is also good serological evidence that subclinical infections occur during epidemics. These may apparently act as sources of spread of infection (Pettit, Mudd and Pepper, 1936). But where is the virus between epidemics? There is no good evidence of recovery of virus from carriers then. Further, between one epidemic and another, the antibody level of the community seems steadily to fall. One would expect to find records of rises in the antibody level of at least some individuals, if subclinical infections were occurring during these long intervals; but in fact the virus seems to disappear for about twenty-one months out of the twenty-four. Our two-yearly rhythm seems to coincide roughly with that occurring on most of the European Continent and in North America. So one can hardly imagine that the virus keeps going by means of infection spreading from one place to another, and finally back to its starting-place. Not even if we bring in the Southern hemisphere can that theory be made to work. Australia, according to Burnet's studies, had major prevalences of "Influenza A" in the winters (i.e. our summers) of 1935 and 1939, about two and a half years later than our recent large outbreaks. In Argentina, influenza was widespread in 1938 and 1940. It seems unprofitable to seek for a solution along these lines.

When we consider swine influenza, we meet with a similar puzzle. Swine influenza breaks out in herds of pigs in the Middle West every winter, but the virus apparently disappears every summer. Shope has lately propounded what seems an acceptable answer to the question of where the swine influenza virus goes to. In his Messenger lecture (Shope, 1942), he has graphically described the story of an outbreak of the disease, of which the essence is as follows: A herd of pigs is perfectly well and eating normally on a certain day in October or November. Next morning almost every member of the herd looks ill and is off its feed; the remainder are poorly by that afternoon. Next day swine influenza is fully manifest: all the pigs are lying down, mostly on their sides

admitted as an influenza virus: whether the difficulty will prove to be a real one. only the future can decide. After some study of his new "Influenza B" virus, Francis went back to sera which he had kept in the cold since 1936, when he had investigated a puzzling outbreak in California (Francis, 1937). Tests on two of these showed that part at least of that epidemic must have been due to the "Influenza B" virus. In the same way we recently retrieved from our cold store sera from the 1939 outbreak in England, and, again, comparison of the antibody titres of samples taken early in the disease and in convalescence indicated that some of these cases were examples of "Influenza B" (Lush, Stuart-Harris and Andrewes, 1941).

*Epidemiological relations amongst different influenza viruses.*—Apart from the serologically distinct viruses A and B, there can be distinguished serological races of "Influenza A" virus, which show varying degrees of antigenic overlap amongst themselves. In the 1937 epidemic we recovered around London at about the same time a number of strains which were serologically separable (Stuart-Harris *et al.*, 1938). Thus this apparently single outbreak was not due to one strain of virus, unless, as seems unlikely, virus mutations had begun to occur freely early in its course. When the far more distinct A and B viruses were separated, they also appeared in mixed epidemics. The first known appearance of B—in the California outbreak of 1936—was not apparently accompanied by much "Influenza A", and B outbreaks have occurred in the absence of A in Minnesota, 1939 (Nigg *et al.*, 1942), N. Carolina, 1940 (Lennette *et al.*, 1941), and Argentina, 1941 (Taylor, 1942). Further, the most widespread outbreaks have all, or nearly all, been predominantly due to the A virus; but in the few years since B was discovered an astonishing number of epidemics have yielded both viruses—England, 1939 (Stuart-Harris *et al.*, 1940), Argentina, 1940 (Sordelli, Taylor and Parodi, 1941), Cuba, 1940, New York, 1940, and Eastern U.S., 1941 (Lennette *et al.*, 1941). Sordelli, Taylor and Parodi suggest that B behaves epidemiologically unlike A; but rather as an endemic virus with seasonal flare-up: concurrence of the two viruses may, therefore, be accidental.

Much more significant in my view is the regular occurrence along with the lesser A outbreaks, of many cases of clinical influenza which yield no laboratory evidence that A or B viruses are concerned. American workers refer to these for convenience as "Influenza Y" (Rickard *et al.*, 1941). The table below gives the different types which were found in 1939 and 1941.

There is a tendency to interpret recent findings as meaning that epidemics are caused by numerous different viruses, only two of which have yet been recognized. But there may be more unity in influenza than such a view would suggest. More facts are needed, but further research will probably show that there are more mixed epidemics than would be expected if the causative agents were wholly distinct and independent. Here, I am thinking especially of the association of "Influenza Y" with influenza due to the known viruses A and B.

Epidemiologists will probably tell me that I worry altogether too much about these immunologically distinct influenza viruses. In epidemics of cerebrospinal fever the different serological types all, or several of them, spread simultaneously: no one expects a Type I epidemic to be independent of a Type II epidemic. In times of war and famine wholly distinct diseases like typhus, relapsing fever and dysentery may rage at the same time. The yet unknown subtle factors which determine an influenza epidemic may similarly favour the spread of "Influenza A" virus, and at the same time of B, and perhaps C and others. This may be all, nevertheless I shall go on looking for some unifying concept which will show us that "Influenza Y"—without any letters attached—is something more concrete than a sudden rise on an epidemiologist's chart.

## II.—VARIATIONS IN PROPERTIES OF "INFLUENZA A" VIRUS

Considerable epidemics occurred in the early months of 1933 (when the virus was first transmitted to the ferret) and in 1937: in those years a large majority of the cases was

### VARIATIONS IN PROPERTIES OF VIRUS IN ENGLAND.

Year	Epidemic status	% A		Ease of adaptation to mice	% B serological test	% "Y" serological test
		Ferret test	Sero-logical test			
1933	++	62.5(?)	—	++ (?)	—	—
1935	+ Army (Dover)	75	—	+++	—	—
	Civil	17	—	—	—	—
1937	++	75	? 100	++	21	55
1939	+	11	24	+	0	22
1941	+	41	78	+	—	—

apparently due to "Influenza A" virus, and virus was transmitted to ferrets from a high proportion of garglings tested. The only strain available from the 1933 outbreak was readily adapted to mice after passage through ferrets (Andrewes, Laidlaw and Smith, 1934) and in 1937 adaptation to the mouse was also fairly easy (Stuart-Harris *et al.*, 1938). The even years, 1934, 1936, 1938, 1940, 1942, have yielded almost no laboratory evidence of "Influenza A" prevalence in England; in the years 1935, 1939 and 1941 A-infection has been apparent, but not on a large scale. There was a big outbreak in 1929 before those of 1933 and 1937, so that it looked as though a four-year cycle of larger outbreaks had become temporarily established; but the small prevalence in 1941 broke the sequence. In 1935, strains from one localized outbreak in the Army infected ferrets and mice very readily; viruses from other localities did so less easily (Andrewes, Laidlaw and Smith, 1935). In the small A-prevalences of 1939 and 1941, it was more difficult than in previous years to establish strains of virus in the ferret, even from cases known to be "A" on serological grounds; it was also difficult to adapt viruses from ferret to mouse, more particularly in 1941 (Andrewes *et al.*, 1941). These variations from year to year are indicated in the table.

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and in respiratory distress; many are coughing: in the next few days a few die, and the rest seem likely to die, but in fact rapid recovery sets in after about six days and the mortality is probably only about 2%. This will not be an isolated occurrence, but the same thing will be happening at the same time to perhaps two dozen other herds within 5 miles: moreover, and this is important, there will have been no contact between the different herds. Such an epizootic has some dependence on the weather, occurring as it does every autumn, but earlier in those years with cold rains and early snows. In addition some other factor may have been noticed. "It may be that the pigs had just a few days before been turned into a cornfield to 'hog it down', or, on a particularly cold night, they may have sweated because of piling up badly in the barn or hog house; or they may have bedded down outdoors around the straw stack on a wet rainy night; or the end door of the hog house was accidentally left open one night; or they slept in a draught; or any one of a number of other things may be held directly accountable by the owner."

Now Shope's thesis is that the virus has been seeded into the herd well ahead of the epidemic, but has produced no disease until some trigger of the kind described in this quotation has fired the epidemic off. Swine influenza is undoubtedly directly infectious from pig to pig, but this explosive outbreak is, he thinks, too sudden to be explained by the ordinary mechanism of droplet infection.

A clue to the mystery is afforded by Shope's (1941) observations on the survival of swine influenza virus in lung-worms of the genera *Metastrongylus* and *Cherstrongylus*, and these are almost universally present in pigs' lungs in the Middle West. In a pig with swine influenza, the lung-worms in its lungs take up the virus, and this is present in the embryonated ova which duly pass out through the pig's alimentary canal. The intermediate host of the lung-worms is the earthworm. Earthworms consume the lung-worm ova which have been passed in the pigs' faeces, and the lungworms go through further phases of their life cycle within the earthworms. In due course pigs eat these infected earth-worms, and the lungworms find their way through the pig's intestinal wall to the lungs—still faithfully carrying the influenza virus throughout their travels. But the infected pig does not thereupon get swine influenza. Some provoking stimulus is necessary to activate it. In Shope's experiments the most regular way of doing it was to give repeated intramuscular injections of live or killed *Hæmophilus influenzae*; but intrapulmonary injection of calcium chloride and other apparently unrelated insults to the pig have provoked the disease. Shope has tried to imitate the kind of upset which naturally determines an epizootic in the field, but has been unsuccessful. But, interestingly enough, no kind of provocation will elicit the disease in properly prepared pigs if the attempt is made in the summer months. Swine influenza virus can survive in worms for far longer than is necessary to explain the carry-over from one epidemic season to the next. Recent studies in the field indicate that this survival is probably of real importance, and not merely an artificial laboratory phenomenon.

It seems a reasonable conclusion that the natural epizootic occurring simultaneously in every one of a herd of pigs can be explained by the action of a provoking stimulus—it is not clear exactly what—on animals already harbouring the virus-infected worms in their lungs.

Now, has all this any importance for the student of epidemics in man? A helminth reservoir of human virus is not inconceivable, but does not seem very likely; it is hard to know what worm could be held to be the responsible agent. The story of the swine virus does teach one very important thing: an influenza virus can exist in a masked or occult form. In the lung-worm ova, in the earth-worm and even in the pig after it has swallowed the worms, but before it has been provoked, the virus cannot be demonstrated directly by inoculation of material into ferrets or mice. Only after this strange, provoking performance, does it shed the mask and become once more recognizable as an infectious virus. It seems to me very likely that human influenza viruses also can exist in an occult form, not necessarily in a worm, not necessarily outside the human being: this thesis I will elaborate presently. Before we leave swine influenza, I must mention that the disease, as it occurs in Britain (Blakemore and Gledhill, 1941) and Northern Ireland (Lamont, 1938), shows some epidemiological differences from what is seen in Iowa: the natural history of the virus is not necessarily the same in the two continents.

#### IV.—ANTI-BODIES AND IMMUNITY

We now come to the puzzling question of the relationship between active immunity and the titre of circulating antibodies. In experiments with ferrets, the amount of neutralizing antibody affords a fairly good guide to the degree of active immunity. The

same is true of the few recorded attempts to test the matter by deliberate experiments on man (Smorodinzew *et al.*, 1937; Burnet and Foley, 1940). But the relation of antibody titre to man's immunity against infection in a natural epidemic is much less definite. Conflicting statements have been made by workers whether using the neutralization or the complement-fixation test. The most recent work, carried out on the most extensive material, is that of Rickard and others (1941). They divided their human material into groups according to the level of their neutralizing antibodies, and found that if the antibodies were low, the chances of catching "Influenza A" were higher, but only 1.6 times higher than the average while, if the antibody was of the highest grade, the chances of contracting the disease were lessened, but again not very greatly, perhaps halved. Thus, if you have a high antibody level, you are entitled to some measure of satisfaction, but by no means to unlimited confidence. The findings are borne out by the results of inoculation with formalized vaccines. These are capable of increasing antibody-level, but from what I have just said, such increase could not be expected to produce a high probability of protection. Nor indeed does it; the latest reports from America record at best a halving of the incidence of "Influenza A" (Horsfall *et al.*, 1941), at the worst no certain protection at all (Siegel *et al.*, 1942). Now, in their studies on antibody levels and on the effects of vaccination, the American workers used, as their main criterion for diagnosing "Influenza A" or "B", the occurrence of a rise in antibody against one of those viruses in the course of the illness. Cases showing no rise against either virus were called influenza of unknown origin ("Influenza Y"). Fig. 2 in their paper (Rickard *et al.*, 1941) shows that the level of antibodies to A-virus did not affect liability to B-infection; this would be anticipated since the viruses are antigenically distinct. But, quite unexpectedly, liability to "Influenza Y" was, in the group with high antibodies to A, much higher than the expected rate. This means that, though high antibodies may halve the chances of getting what a laboratory worker is pleased to label "Influenza A", the prospects of contracting the very unpleasant disease popularly described as "flu", are much less affected. In some studies a favourable effect has been produced, by inoculation, on the incidence of "Influenza A", but very little on that of clinical influenza as a whole. American workers have put forward an explanation of these phenomena: They have found that in persons with initially high antibodies, vaccination causes a relatively small increase in titre; it is arguable then that people having high titres, whether naturally or as a result of vaccination, might suffer from actual virus infection without any change in antibody-level. The artificial serological criteria used for diagnosing "Influenza A" infection would then naturally lead to their being labelled "Influenza Y": hence the excess of influenza of apparently unknown causation in those with high A-antibodies. There is certainly something in this argument, whether or not it will wholly cover the facts. Another possible explanation will be mentioned later.

Here, then, are our difficulties: First, we have periodical outbreaks of influenza; the major ones are apparently due chiefly to "Influenza A"; others may be due wholly or partly to "Influenza B". In others, however, we fail to detect in many cases any signs of the presence of the influenza viruses we know about, though the illnesses are clinically like those of known "Influenza A" and "B" virus infections, and occur along with them.

Second, "Influenza A" viruses vary from one outbreak to another, both antigenically, in their rapidity of spread in the human population, in the ease with which they are established in ferrets and in the ease with which the ferret-adapted strains can be got to infect mice. On the whole the strains most infective and virulent for man have been those which most readily infect laboratory animals, but this relationship is by no means certain. Third, we have to discover where "Influenza A" virus lies quiescent for twenty-one months out of twenty-four. Can it, as seems likely with swine influenza virus, persist somewhere in an occult form? Fourth, some relationship is shown to exist between the immunity of an individual and the level of neutralizing antibodies in his serum; yet potent antibodies only diminish to a limited extent his liability to infection.

To find a solution let me picture what I will term a basic influenza virus, stripped of a number of its properties, including all or almost all that A-antigen which makes it recognizable to us serologically as "A-influenza" virus. It would then resemble the degraded forms of many bacteria which exist in a form lacking a familiar antigen. Loss of these various properties would, we may imagine, prevent it from multiplying rapidly, causing symptoms in its human host, or stimulating in him formation of A-antibodies; it would lead to loss of power to infect ferrets, mice and chicken embryos. In other words, the virus would lack all the properties by which we in the laboratory can detect its presence. It is perhaps less of a jolt to our preconceived ideas to picture this basic



virus as a latent virus persisting harmlessly in cells of human carriers, but if we accept Shope's findings in earthworms, we must not rule out the possibility that it hides in some other host between epidemics. It is likely that basic virus does not persist indefinitely in a large proportion of human beings, for in small isolated communities such as St. Helena and Tristan da Cunha, influenza tends to disappear for long periods, and not to recur every two years or so as in Britain and North America.

Ability to form A-antigen and perhaps other properties affecting virulence may be supposed to vary quantitatively. To try to explain everything in terms of A-antigen alone is probably to over-simplify, but it is not unlikely that there is a tendency for several properties to increase or diminish *pari passu*.

In winter when other respiratory pathogens pass from host to host more easily, our basic virus is helped to travel too, and a chance passage through several successive hosts with low A-antibody or otherwise poor resistance may increase its virulence and power to make A-antigen. We can see how quantities of A-antigen could help the virus by "saturating the defences". Our first line of defence is probably the virus-inactivating agent discovered in human nasal secretions independently by Burnet and Francis. Burnet (Burnet *et al.*, 1939) has adduced evidence that this acts differently from antibody and thinks it may be an enzyme akin to, but not identical with, lysozyme. Francis (1940a, 1941), on the other hand, has shown grounds for identifying it with specific antibody. Which of them is right remains to be seen. In either event the reaction is likely to be with A-antigen on the surface of the virus. Now we know that potent A-antibodies, though not useless, are of extremely limited value in diminishing one's chances of contracting influenza in an epidemic. Burnet (1942) has made the valuable suggestion that the first cases of influenza in an outbreak may be found to occur in people with low antibody. The evolution by the virus of more and more A-antigen—or something else which reduced the efficacy of the specific means of defence—would render it capable, as the process went on, of infecting a larger and larger proportion of the community including, later, those with relatively high antibodies. Chart I depicts graphically the properties of "Influenza A" viruses of various grades of virulence. If such a gradation has any reality, influenza becomes easier to understand. But I had better admit that only the middle reaches of the chart have any justification as yet in experimental facts. Grade I, the basic virus, probably spreads very little, but remains between epidemics in a small number of human carriers—possibly elsewhere; under special conditions, however, it is disseminated, probably in advance of a recognized epidemic. Whether it would immunize against overt disease one cannot say, but if so, and if such a virus spread through a community without further increase in virulence, one might expect it would prevent an epidemic of overt disease from arising and causing trouble. More will be said later of the possibility of controlling influenza by artificial immunization with a living virus of negligible virulence. But let us note that Freeman (1941) has lately reported that a mouse-pneumonia virus may be carried as a latent infection by stocks of mice, all members of which are highly susceptible to strains of the same virus after its virulence has been raised by passage. Grade II virus is the hypothetical agent causing a large number of those cases of influenza which occur mixed with "Influenzas A or B", but get labelled "Influenza Y" because no evidence of the workings of A or B is to be detected. (I am not suggesting, of course, that no "complete" influenza viruses other than A and B remain to be discovered.) Possibly, also, influenzas of the even years, when A is not detected, may prove to be due in part to "incomplete" or Grade II viruses.

Grade III viruses perhaps acquire at about the same time ability to infect ferrets and to make much A-antigen; at times the one property may be acquired first, at times the other. We have already mentioned that in some outbreaks it may be impossible to infect ferrets with virus from cases proven serologically to be "A-influenza". On the other hand Grade III would include viruses such as Glover and I encountered in 1941 (Andrewes *et al.*, 1941). Seven "strains" were then obtained from garglings of influenza patients, and these were apparently propagated for a number of passages in ferrets before they petered out and were lost. Tests on sera from recovered ferrets in each of these series showed that no antibodies against A or B viruses were present. Fever and symptoms in ferrets were usually typical, but there were more symptomless infections in a transmission series than were encountered with A-strains isolated in the same year. A bacterial cause for the ferret symptoms was apparently excluded. We felt that an agent was being transmitted, but that this could not be securely established in ferrets. The results contrasted with those of 1940, when all material inoculated into ferrets gave unequivocally negative results. Similar elusive "doubtful strains" have also been met with in the United States (Lennette *et al.*, 1941) and Canada (Hare *et al.*, 1942).

With Grade IV strains we reach firmer ground. Patients from whom these are obtained develop A-antibodies during their illness. Ferrets are infected in a varying proportion of attempts, and viruses after passage through ferrets can usually be adapted to mice, though often with some difficulty. Such viruses have been met with in England in 1939 and 1941, and recent American strains probably come also into this category.

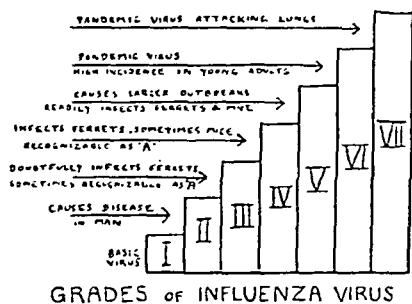


CHART I.

Grade V viruses are those which have caused more widespread outbreaks over here in 1933 and 1937, and which infect ferrets and mice with relative ease. Australian 1935 and 1939 strains would be included in this group. We have not yet enough information to guess what grade of virulence has to be attained before amniotic inoculation, as described by Burnet (1940), will be successful. We do not know what relationship exists between the pandemic influenza of 1918-1919 and those of the last decade, though many people, including myself, would guess that influenza virus underwent an antigenic mutation about June 1918, enabling it to spread in an unwonted manner, especially in young adults; such a virus would belong to our Grade VI. A further mutation or enhancement of virulence occurring about August 1918 would give us Grade VII, capable of causing many fatal pneumonias. So far "Influenza B" virus has not shown itself capable of rising higher than Grade III or IV. Possibly it runs up and down the scale of virulence independently, apart from a common seasonal factor, of what its cousin "A" is doing. But, knowing what we do of the potentialities of a rough pneumococcus (cf. Griffith, 1928), we cannot ignore the possibility that our basic virus has the power to develop either A or B antigen, or perhaps others, yet unrecognized.

The occurrence of influenza in an individual or a community is unlikely to depend solely on the grade of influenza virus; no doubt specific and non-specific resistance of the individual or community, weather and social conditions also play their part. The diagram therefore cannot achieve the impossible in elucidating the problem of influenza. Nor need the influenza viruses of one outbreak all belong to one grade. Rather will the mean of the virulence-grade of prevalent viruses vary from time to time.

Two facts, when placed in juxtaposition, give occasion for serious thought. Chart II shows that this country was remarkably free from influenza for some years prior to 1890, but following the epidemic prevalence of the early '90s, the incidence of influenza has never fallen to a level approaching that of 1890. Evidently an abnormal influenza epoch set in. Various causes may have been concerned. To quote Greenwood (1920): "Something is to be allowed to fashion in nomenclature; but when all discounts equitably due have been made, it will still be found that the position lost in 1890 has never been regained." It is noteworthy that data from the European Continent, North America, and Australia show the same state of affairs as those from England and Wales. Our present interest is in placing the fact alongside this other fact: in years such as 1934, 1936, 1938, 1940 and 1942 "Influenza A", so far as we can judge from laboratory tests, has been practically non-existent in England. These have been years during which, as I have already mentioned, the prevalence of clinical influenza was high in comparison with that of the pre-1890 era. Apparently then, waves of "Influenza A", at any rate since the virus was recognized in 1933, have been superimposed on an increased prevalence of something which is not "Influenza A" as we know it. Maybe several diseases simultaneously acquired greater importance after the influenza epidemic of 1890, owing to different social conditions, but it is a little hard to believe. I feel more attracted by the hypothesis that the influenza virus has been regularly taking a heavier toll of human lives since 1890 than in the previous forty years, but that only in certain years

have circumstances allowed it to attain that grade at which it becomes recognizable to us as "Influenza A".

I cannot report concrete facts concerning the quantitative variation in the amount of A-antigen made by influenza viruses at different times; for we only know how to study

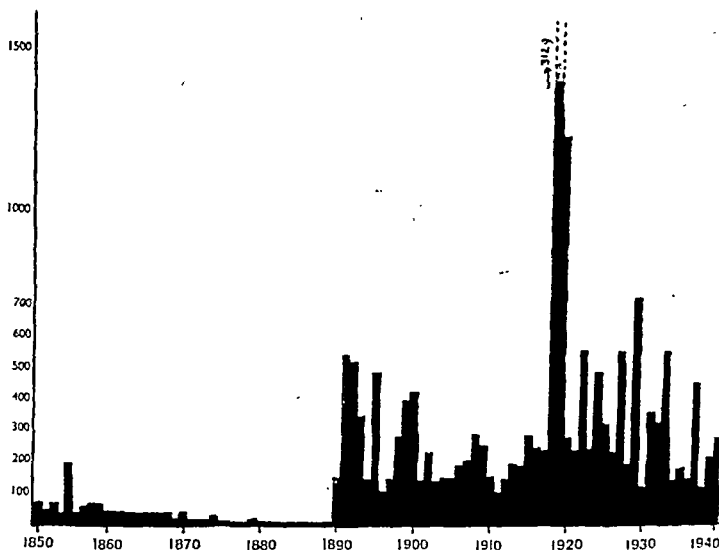


CHART II.

Influenza deaths per million, England and Wales.

those viruses which are readily adapted to laboratory animals, and once they have reached that stage, all strains seem to make plenty of specific antigen. I feel that the conception of a base influenza virus does suggest new lines of experimental attack. I wish we knew as much of the chemical nature of influenza virus as we do of those of vaccinia and tobacco mosaic. Unfortunately influenza virus tends to be mixed with tissue particles of much the same size as itself and purification by physical methods is therefore harder. It would seem to me worth trying to strip the A-antigen off the virus chemically and seek for something underneath recognizable by serological methods. One might thus find a new approach to epidemiological study by learning how to recognize infections with the lowest grades (I-III) of the virus.

In winter-time a certain number of people may be carrying avirulent basic influenza virus. The seasonal coughs and colds permit the spreading of this virus, and passage through a series of unduly susceptible persons allows it to increase its grade of virulence till it can cause symptoms in man. It is perhaps noteworthy that three recent descriptions record that influenza outbreaks in communities followed a few weeks after epidemics of febrile-catarrhs which yielded no virus (Stuart-Harris *et al.*, 1938, 1940; Siegel *et al.*, 1942). These sequences may not have been accidental; the catarrhs may have played a part in the genesis of the influenza outbreaks. One should not, however, expect a catarrhal outbreak to precede one of influenza in every locality. A moderate view would picture epidemics of influenza not as arising from a single source nor yet from latent infections of ubiquitous distribution, but rather from a limited number of scattered foci. When virulence had been stepped up locally, further spread by droplet infection could occur in the orthodox way. Increase in grade of virulence and spread through the community would be expected to be accelerated, or to slow down and cease, according to the strength of various factors including, probably, the average antibody-level. It is hard to say whether, as in swine influenza, a change in weather or some other trigger plays a vital part in determining the onset of a recognizable epidemic; we must beware, in this connexion, of thinking only of an English January; twice in recent years outbreaks have occurred in the West Indies in late summer. Just as passage through very susceptible persons has been pictured as leading to an increase in "grade" of virus, so passage through those relatively immune would be likely to induce a fall, perhaps more rapid than the rise. Here, maybe, lies the explanation of the excessive numbers of "Y"

influenzas in people with high antibody-titre. The difficulty is that, if virus in such persons rapidly became degraded and lost its A-antigen, we could not, with our present methods, detect that virus was present at all; we should merely fail to infect animals, fail to detect an antibody-rise in our patient and label him "Y" or "Influenza of unknown cause".

The outline I have given of a gradation in properties of influenza viruses from basic virus to pandemic virus may prove to be far from a true picture. But, if true, it would afford a feasible explanation of our difficulties—of the failure to find A-virus between epidemics, of the occurrence in many outbreaks of mixtures of A and Y, of the variations in biological properties of viruses isolated at different times, and of the anomalies in the relation between antibody-titre and active immunity. Can the picture help us to see how to prevent or control influenza epidemics? It might, I think, hint that the sequence of events leading to an epidemic is complex and might be interrupted at several different points. First, it could be attacked at its beginnings when virus of low grade is being given opportunity to spread widely, and to find a favourable medium for improving its status. Much has been written lately on the possibility of improving aerial hygiene in the future by better ventilation, ultra-violet light and antiseptic mists. I like to hope that such measures, if they decrease other respiratory infections, will make it difficult for influenza virus ever to get up its evolutionary momentum. But if the first stages of up-grading of the virus have been passed, we may yet hope to make conditions unfavourable for the parasite's further progress. Present methods of vaccination have, as already mentioned, only a limited value in protecting individuals. But I should not be surprised if influenza quickly faded out if introduced into a closed community, most, or all, of whom had been vaccinated recently, and whose antibody-level was accordingly high. Such would be more likely to happen if the virus had not already attained too high a grade. Since influenza strikes different communities in what now seems an unpredictable manner, it will naturally be a matter of very great difficulty to determine whether or not the antibody-level of a group plays a part in determining its freedom from attack—a far harder problem than that which has already proved difficult to decide as regards the individual. Burnet (1937) has suggested that intra-nasal instillation of living attenuated virus might prove an effective immunizing procedure. This idea has great theoretical advantages, but at present we do not know how to obtain at will a safe and effective attenuated virus. I should liken the use of such a virus to the lighting of small controllable fires in advance of a dangerous spreading conflagration. One could do it only in the face of a grave menace, and if one were fairly sure that the fire one lit could not itself get out of hand. Another method of control has been suggested by Smorodinzew and others (1940)—local passive immunization of the respiratory mucosa by inhalation of atomized antiserum; very good results in man are claimed. Experimentally, such a method has proved effective in protecting mice against influenzal pneumonia, but much less so in preventing the nasal infection of ferrets (Taylor, 1941; Zellat and Henle, 1941).

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## Section of Ophthalmology

President—FRANK A. JULER, F.R.C.S.

[October 9, 1942]

### Recurring Juvenile Vitreous Hæmorrhage

#### PRESIDENT'S ADDRESS

By FRANK A. JULER, M.A., M.B., F.R.C.S.

THE condition known in this country as Eales' disease was first described in 1880.

A summary of the literature and a description of the disease were given in 1932 by H. P. Hutchinson. Since that date there have been few references to it here, but on the Continent and in America it has received some attention.

Hutchinson (1932) concluded *inter alia* (1) that no constitutional disease is usually present, but often some measure of lowered vitality seems to exist, (2) that there is no satisfactory evidence that tuberculosis is a cause, (3) that the disease is probably due to a deficiency in some blood constituent or to the presence of some toxic product causing damage to the capillary endothelium with resulting diapedesis. He mentioned too a possible vitamin deficiency allied to scurvy, although no symptoms of scurvy except epistaxis have been noticed.

Lawson (1935) in a discussion on diseases of the blood, stated that Eales' disease was characterized by a marked increase in the coagulation time of the blood. I have not been able to find any confirmation of this nor have my own observations shown that this is true. As Hutchinson says: "Deficiency in calcium, prolonged bleeding time and delayed coagulation seem to be ruled out in almost every case in which these points have been investigated."

R. T. Paton (1938) described five cases, and concluded that the condition was always traumatic, toxic or infective.

Jéandelize and Drouet (1936) attributed the disease to an endocrine defect. They assert that there was a condition of hyperpituitarism which might either be primary, or secondary to hyper- or hypo-thyroidism or to dysfunction of the adrenals or gonads. Its presence was shown by the detection in the urine of a melanosome-dispersing factor. The only other evidence which they give is (1) a narrowing of the visual fields, chiefly bitemporal, amounting to ten or twenty degrees, (2) a hypertension of the retinal arteries.

Recent work by Noble and others (1938) on the posterior lobe of the pituitary has shown that injection of its extract produces pressor effects and hyperglycæmia, sometimes with achlorhydria and hyperchromic anæmia, whilst the urine of the experimental animals contains substances producing pressor and anti-diuretic effects; tested on the frog a melanosome-dispersing action is obtained. Idris Jones (1938) has described a case in which these findings were detected clinically and diagnosed as due to an over-activity of the posterior lobe of the pituitary gland. His patient was a man of 26 and the disability lasted only a few months. There was no vitreous hæmorrhage.

Dax (1938) reported the presence of a melanosome-dispersing substance in the blood and urine of eight adult mental defectives with retinitis pigmentosa. Idris Jones tells me that he would hesitate to say that this substance is pathognomonic of hyperpituitarism, but should there be other evidence of excessive pituitary action, then it could be used as a confirmation.

McArey and Somerville-Large (1939) showed two cases of Eales' disease with a low excretion of vitamin C in the urine, both of which had suffered no relapses since that diet was augmented. The period of freedom from recurrence is, however, not stated. Several observers, including Hutchinson (1932) have suggested that some deficiency condition may be present in this disease, and the above observations invite confirmation.

Harris (1940, 1942) recently found that school children show a low level of vitamin C at the end of the winter, and that the present average is lower than in a pre-war period. Figures for the age-group corresponding to that of patients with Eales' disease can be obtained from papers entitled "Vitamin C Survey of Medical Students" in 1939 and 1940 (Harrison *et al.*, 1939; Francis and Wormald, 1942). The latter year shows a lower level, presumably owing to war-time diet.

The symptomatology of severe vitamin C defect is described by Crandon (1940).

These researches indicate that ascorbic acid is stored in the body, and that a high blood and urine content is only found after saturation has been reached. The determina-

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Flint and Harrington (1934) described the formation of small vessels as occurring at the site of hæmorrhage into the vitreous and noticed their retrogression later as the vitreous cleared. In this case there seemed no other lesion to account for the hæmorrhage. The spot on the upper right hand corner of the sketch has disappeared eighteen months later.

The patient was a male, aged 31 at the time of his first obscuration. He is an active man in excellent health. The right eye alone has been affected. No fundus change can be found in the left eye. There has been no iridocyclitis. His case was observed over a period of five and a half years and there have been some five or six attacks of which the second was the only severe one. In this vision was reduced to hand movements but had recovered to 6/9 after nine months. The sketch was made after the last attack, two years ago.

Clinical examination and routine investigations, made within a few weeks of his severe second attack, revealed nothing abnormal. Radiography showed gross mucosal thickening of the maxillary antra, whilst in the teeth there was some apical absorption and peri-apical necrosis, with slight alveolar erosion in the upper incisors.

The clotting time of the blood was five minutes, and it was interesting that this time was lengthened to five and a half minutes a few hours after intravenous injection of calcium gluconate, whilst the same time was registered the day after an intravenous injection of calcium chloride. The serum calcium content of the blood-serum was 9.9 mg. per 100 c.c. and the plasma phosphorus was 4.7 mg. per 100 c.c., both figures being within the normal.

CASE II.—A similar appearance was seen in B.—F.—, in whom the retina also showed a localized detachment containing venules: these vessels were bowed forward, narrowed and kinked. Some evidence of periphlebitis had been noted on the occasion of the first hæmorrhage in a sheathing of two of the superior venous branches; it seemed possible that the hæmorrhage had come from the same venules on the three occasions in which a study of his fundi were made after an attack.

This man, a well-nourished Jew, aged 29, stated that his several attacks had always come on after an exertion somewhat in excess of those made in his usual sedentary occupation. He had no iridocyclitis, but a few small round foci of choroiditis were noted, which seemed to be of old standing and not to be connected with the bleeding points.

A search for an aetiological factor failed. He had some dilated veins on the legs, but had had no phlebitis in connexion with them. The blood Wassermann was negative, the blood-count normal and no abnormality could be detected in general clinical examination. His case had been under observation for three and a quarter years, during which he has had three attacks, all in the right eye; the visual acuity has cleared to 6/6 on each occasion.

CASE III.—A woman (E. K.), aged 25. The left eye only was affected. An upper retinal vein seemed to provide the leaking point, and three weeks after the first onset a whitish area surrounded by some pigment was seen some way from the optic disc on the nasal branch of the superior temporal vein. Two months after the second relapse, a sketch was made and showed a patch on the same vein with brownish fibres coming from it, suggestive of a source of the hæmorrhage. After a third attack, four months after the second, the fundus could be seen fairly well, and around the site of the supposed leak some retinal edema was apparent together with a thin layer of subretinal hæmorrhage. Two more profuse attacks at intervals of three weeks followed, and as vision three months later was still reduced to hand movements, an aspiration of the vitreous was attempted. Only a minimum of fluid was evacuated, however, and although some clearing of the vitreous after an attack of iritis improved vision to finger-counting at two metres, a detachment of the retina occurred which did not respond to operation, and the eye became blind.

All routine examinations, here again, were entirely negative. Radiography of the skull showed nothing abnormal; the blood calcium at 12 mg. per 100 c.c. of serum was slightly higher than normal.

CASE IV.—S. W., male, aged 37, whose left eye only was involved, was not followed over any length of time, and is mentioned because he had a chronic osteomyelitis of the great trochanter, which had followed an injury at the age of 14. There was no evidence clinically or radiologically that this was tuberculous, though the possibility could not be excluded.

CASE V.—M. G., now aged 32, a well-built married woman, has been under observation for ten years. During that time the left eye only has been affected and has suffered at least five attacks, although none has occurred for seven years past. Her first attack occurred with an anterior uveitis, but in the subsequent ones, the vitreous hæmorrhage has been the outstanding feature. With the development of a retinitis proliferans the attacks ceased. After the last attack the vision improved from finger counting at twelve inches to 6/24 in three months. This attack was treated with intravenous calcium chloride, but owing to some leakage into the tissues, a fairly severe cellulitis of the arm developed. This may be worth notice, as a form of shock therapy, for after this no further attacks occurred.

This woman maintained that her relapses occurred with menstruation, on one occasion simultaneously with a severe attack of nasal catarrh. The menstrual association has been noted by Jeandelize and Drouet (1936) and by Foster Moore (1922). No general cause was discovered. The blood coagulation time was three and a quarter minutes on one occasion, and during a menstrual period it was found to be four minutes. A blood-count showed only a slight anaemia, the colour-index being 1.0, the hæmoglobin 82%. Blood Wassermann reaction was negative, and gynaecological examination showed only a small erosion of the cervix.

CASE VI.—A. B., male, aged 28 at the onset of the attack, was observed for three and a half years. During that time the right eye only was affected. In the first year several slight attacks were reported. Then a severe one reduced vision to finger counting at twelve inches, but this had been restored to 6/5 in nine months' time. Two and a half years later, a mild attack of "streaks" occurred, 5/5 being regained later.

Though there was no evidence of iridocyclitis, there was here again a suggestion of periphlebitis in the appearance of white bands ensheathing a peripheral vein in the upper part of the fundus, three weeks after the severe attack. Nine months later an inferior nasal vein at 3.30 was noted as kinked, and terminated in an area of whitish tissue in the retina, possibly a source of hæmorrhage. Following the last attack two and a half years later, a clot was noticed at 4.30, just below this old scar, suggesting that the same site had leaked again.

General examination, six days after his severe relapse, revealed nothing abnormal except that the blood-pressure was high at 154/110. The blood coagulation time was five minutes.

CASE VII.—L. J. P., male, aged 18, when the first hæmorrhage occurred in the right eye. He was under observation for one and a half years only and during that time he had three attacks, the left eye not being affected. After the last attack, acute iridocyclitis with low tension followed a slight trauma. The attack in this man did not clear up at all well (6/36 was the best registered) and no notes of the fundus changes are available. It would seem possible that the usual attack may have been associated with an extensive retinal periphlebitis, for vision was reduced to finger counting. His general condition was noted as good.

CASE VIII.—L. B., male, was 21 years of age at his first alarm. He was, and is, a man of sturdy physique in apparently perfect health. His is the only case in this series in which both eyes have been affected, but the left eye was not attacked until four years after the other. Each eye shows evidence of iridocyclitis.

The fundus sketch of the right eye (fig. 2) was made one year after the last attack, and the details were somewhat difficult of definition, owing to secondary changes in the lens. This eye had had several attacks over five years, the last one a year ago, associated with a sharp iritis. During the last six months the vitreous has cleared considerably and it can be seen that the fundus changes are extensive. All the retinal vessels are attenuated, but the superior nasal branches are markedly so. At 1 D.D. from the disc these upper vessels disappear into a patch of retinal atrophy, and emerge beyond as residual white lines only. The whole appearance suggests a perivasculitis of both artery and vein with permanent occlusion.

The left fundus is still obscured by masses of hæmorrhage, the only definite visible change is a superficial patch of choroidal degeneration quite separate from any retinal vessel.



tion of the body content therefore requires more than a simple estimation of the amount of vitamin C in the urine or plasma.

Though in my cases no investigations were made on this possibility, from clinical experience during the last two years of war it does not appear that Eales' disease is on the increase, as one would expect if an ascorbic acid deficiency of a mild type were in some way a factor.

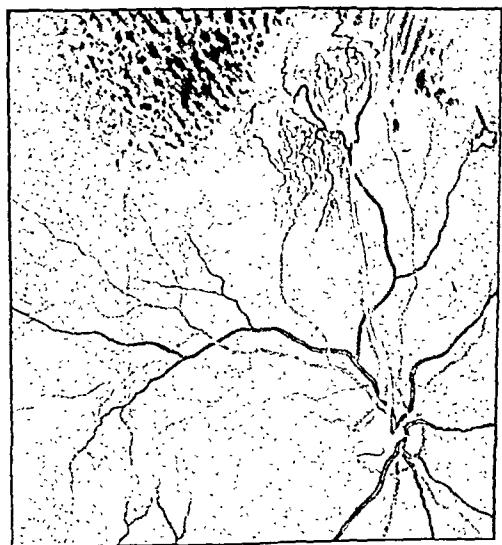
In "Modern Trends in Ophthalmology" (Ridley and Sorsby, 1940) Reddick emphasizes the presence of an actual periphlebitis of a tuberculous nature, an explanation which was strongly supported by Axenfeld, Stock and others. He refers also to Marchesani's theory that Eales' disease is a manifestation of Buerger's disease (thrombo-angiitis obliterans). Marchesani's patients had circulatory disturbances varying from a simple sensation of cold to a spontaneous gangrene of the extremities. Kokott (1935) investigated five cases; no evidence of Buerger's disease was discovered, nor have any symptoms of this kind been detected in my own patients.

Duke-Elder (1940) states that Eales' disease is the commonest clinical type of tuberculous periphlebitis, but that it may also occur as the result of septic foci, Buerger's disease, helminthiasis, delay in blood coagulation time, endocrine defects, and calcium deficiency. "The main feature in most cases is the normality of the general metabolism."

With regard to *tuberculosis*, the absence of clinical evidence in most cases is definite, but cases with active pulmonary lesions have been recently reported by Bonnet *et al.* (1936), and Kokott (1935), whilst Somerville-Large (McArey and Large, 1939) saw three cases of Eales' disease with old standing tubercular lesions in the hilar glands. Microscopic examination is not possible, but Fleischer in an excised eye found a single focus of inflammation in the ciliary body, hæmorrhages along the retinal veins and on the retinal surface, with tuberculous nodules in the vein walls. Gilbert (1935) found tubercle bacilli in a nodule in the wall of a vein; the eye had been excised for secondary glaucoma in a young man suffering from severe pulmonary tuberculosis: it is not a typical case of Eales' disease, but it proved that tuberculous periphlebitis does occur.

#### PERSONAL OBSERVATIONS

The appearances in the fundus are in most cases obscured by the grossness and density of the vitreous opacity, but in some of the less severe attacks it is possible to see the apparent origin of the hæmorrhage and in others a residue can be seen when the hæmorrhage has cleared.



(Clement Clarke.)

FIG. 1.—Case I.

CASE I.—The first sketch was made from a case (S. M.) after several attacks had occurred and during these a band of organized vitreous opacity had formed. The recent hæmorrhage can be seen (fig. 1). At the end of the vitreous band the retina is pulled forward to form a localized detachment in which a branch of the superior temporal vein shows as a narrow dark vessel from which comes a brushwork of fine tufts. These are either remnants of hæmorrhage from the site of bleeding or some dilated capillaries in the retina or some new formed vessels.

signs of a diffuse perivasculitis with narrowing of all the retinal vessels and complete occlusion of some of them.

In conclusion, one may say, therefore, that the local lesion may be a simple leak but is usually a periphebitis or perivasculitis of a variable intensity, and that there is no evidence that this is due to focal sepsis, tuberculosis or, indeed, to any specific disease. Some cases are associated with an inflammation of the uveal tract.

#### PROGNOSIS

Although some eyes are undoubtedly badly damaged, the majority retain good vision.

In many of the cases reported in the literature and in those which form the basis of my paper, hæmorrhages do not recur after a varying period. In Hutchinson's cases (1932) this was from six months to four years.

Of my cases, only one has been watched a sufficient length of time to be certain that there is no further danger. In that patient, seven years have elapsed since the last hæmorrhage, which was one of five over a period of three years (No. V). In another (No. VIII) the right eye had many relapses over a period of five years, finishing with an iritis, and has been free for thirteen months. His left eye had several hæmorrhages during a period of eleven months and has been free for eight months.

Two others have been free for eight months, one (No. I) after five hæmorrhages in five and one-half years, a second (No. III) after four hæmorrhages in one and a half years.

The intervals between the attacks vary from a few weeks to three years, but the average is approximately nine months.

My figures as to the period of susceptibility suggest a term of one to five years and agree approximately with those given by Hutchinson.

The majority of relapses are mild, and render the vision smoky for a few weeks only, but the worst ones have reduced the vision to hand movements. In all such severe cases, except one, there has been improvement, one attaining to  $\frac{5}{6}$  in nine months, and  $\frac{5}{6}$  partly later in spite of a relapse, another reaching  $\frac{5}{8}$  in six months, another  $\frac{5}{6}$  in four months, when iritis obscured the prospect. In several, the acuity, at first reduced to the counting of fingers, improved in the course of weeks or months to  $\frac{5}{6}$  and even  $\frac{5}{6}$ .

One may conclude that in the great majority of attacks the visual acuity is only temporarily impaired, but that there is always danger of a serious attack during the period of susceptibility. Even these severe attacks have a fair chance of good recovery.

#### TREATMENT

(1) *The immediate treatment.*—At the onset complete rest in bed for a few days is advisable, in order to help clotting at the site of rupture.

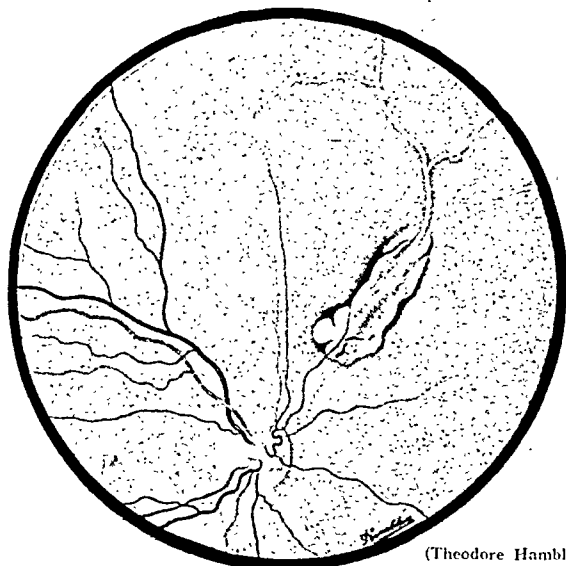
None of the coagulant drugs appears to be of any value. I have no evidence of any prolongation of the coagulation time in this disease, and Professor Huggett says that the normal will not be shortened by increasing any single factor in the complicated mechanism involved in blood coagulation. Intravenous injections of calcium gluconate and chloride in one of my cases were not followed by any shortening of the coagulation time. In the same way, hæmoplastin and vitamin K cannot be expected to be of value. The hæmorrhage is not due to any deficiency in the coagulation power of the blood, it must be due to the local lesion in the vessel wall.

(2) *The treatment of the predisposing disease and of the vascular lesion.*—The general well-being of the patient is most important. The ideal is a sheltered life, with a quantum of sleep, good food and gentle exercise.

In the background is the prevention of recurrences. The periphebitis or perivasculitis in the area concerned is usually of a mildly infective nature, but any definite focus may require radical treatment. Apart from this, it may be well to attack the infection by general empirical means, such as protein shock therapy by means of the intravenous injection of T.A.B. vaccine. Such treatment might stop further infection, although it need not be expected to strengthen the resistance of weakened walls.

That such reactions may benefit is suggested by the effect of a fairly severe chemical cellulitis in the arm in Case V, following a leak of calcium chloride into the tissues during an intravenous injection of that drug. As already related, this woman had had at least five attacks in three and a half years, but after this accident she had had no recurrence up to seven years later.

The other possibility of stopping recurrences is by diathermy. In his Bowman lecture, Weve (1939) pointed out many uses for the high-frequency current in ophthalmic treatment, and in certain cases of Eales' disease it might be suitable of application. Some of my cases appeared to have bled from the same vessel on succeeding occasions. It would seem justifiable to produce a reaction over the area affected so as to include the "phlebitis



(Theodore Hamblin.)

FIG. 2.—Case VIII.

This case is of interest as seeming to provide a link between the typical cases of Eales' disease and the more severe and rarer cases of perivasculitis of the retina. No definite cause was detected to account for his trouble. Clinical and radiological examination revealed no abnormality and tests for tuberculosis were negative.

It may be noted that this man has had no attack in the right eye for one year following an iritis and possibly occlusion of the retinal vessels by perivasculitis. Nor has he had any fresh trouble in the left eye for eight months, although there had been many attacks during the previous year. He attributes this immunity to his general well-being and quiet life.

*Summary of general findings.*—In the eight cases described, there is a striking absence of any tangible general disease, except one in which there was a chronic osteomyelitis of the great trochanter.

In no case was any evidence of tuberculosis obtained. This is in contrast to the findings in a recent study of chronic recurring iridocyclitis (Brooks *et al.*, 1940) in which clinical or radiological evidence of tuberculosis elsewhere in the body was present in twenty-five of the forty patients.

Another negative feature was the absence of any general tendency to phlebitis or venous thrombosis.

On the contrary, all the patients save the one with bone disease were physically and mentally in good health. Possible sources of sepsis such as tooth or tonsillar pockets, were not found during routine examination.

I regret that investigations concerning a possible hyperpituitarism and vitamin deficiency have not been carried out. In only one case (No. VI) was the blood-pressure above the normal for the age of the patient nor was any increase in the colour density detected in the routine blood-counts, such as might have been found if a posterior lobe hyperfunction had been present.

*Summary of ocular findings.*—In three of the present series iridocyclitis was present and foci of choroiditis were found in one other. The iridocyclitis was non-recurring and for the most part of a mild type.

The ophthalmoscopic study of this series of cases suggests that in many the hæmorrhage occurs from one or more branches of a retinal vein, and that recurrences may occur from the same site, leaving little residue beyond a twisting and kinking of the vessel, sometimes associated with a localized traction forward of the retina. It has been recorded by several observers that occasionally no change can be found in the fundus after the vitreous has cleared. This has led to the suggestion that a diapedesis rather than a loss of continuity supplies the actual hæmorrhage. A complete recovery is not incompatible with a localized phlebitis, but is perhaps also not inconsistent with a weakness, congenital maybe, of the vein wall. Such a congenital defect has been suggested before, and undoubtedly weakness of veins is seen elsewhere in the common varicosities in the legs, though I am not aware that other similar anomalies are recognized.

In other cases there have been more definite signs of periphlebitis in the way of white sheathing of the venules, with subsequent development of kinking. In another there were

## Section of the History of Medicine

President—Sir WALTER LANGDON-BROWN, M.D.

[October 7, 1942]

### Chapters of Cambridge Medical History

#### II.—Francis Glisson and the Insurgent Century<sup>1</sup>

#### PRESIDENT'S ADDRESS

By Sir WALTER LANGDON-BROWN, M.D.

THE sub-title of this paper is borrowed from Dr. Charles Singer who, appropriately enough, attaches the label "insurgent" to the seventeenth century. Yet it seems to me that the hundred years, 1588-1688, which separated the Armada from the Revolution were the really insurgent ones. I am impressed with what a large proportion of Elizabethan splendour was post-Armada. In 1588, as far as we know, Shakespeare had not written a single play; indeed, much of what we call Elizabethan drama was Jacobean. And no one would question that after 1688 insurgence died down and the Age of Reason dawned.

I think Hilaire Belloc is probably correct in attributing the settlement, after several swings of the pendulum, of the English Church on the side of Protestantism as largely due to the threat to the nation by a Catholic foreign power. Scholasticism, so long identified with Catholic theology, received its final quietus. Unfortunately, the struggle between Roman and Anglican was replaced by one between the Established Church and Puritanism. But on both counts, intellectual and religious, a great effort was being made to see things as they really are. As Mr. Basil Willey points out, "it may be said that if there was then any outstanding intellectual revolution in process of enactment it was a general transference of interest from metaphysics to physics". Or we might say the divorce between moral and natural philosophy had begun. This was the mental atmosphere in which Francis Glisson was born just before the turn of the century; an atmosphere soon to be intensified by Francis Bacon. . . . "The *Noëum Organum* and the *De Augmentis* are much talked of, but little read. They have produced indeed a vast effect on the opinions of mankind; but they have produced it through the operation of intermediate agents. They have moved the intellects which have moved the world" (Macaulay).

It was this search for new truths which influenced the atmosphere in which both Harvey and Glisson grew up. Though Glisson appreciated what he owed to Harvey, Harvey did not appreciate what he owed to Bacon. There was some excuse for this. Bacon left out of consideration the scientific use of the imagination, by faith in which Harvey saw the capillaries which Leeuwenhoek subsequently discovered by the aid of his microscope. When Thomas Hobbes said that Harvey was the only man who had seen his theories accepted during his lifetime, he must have been thinking of the younger generation, for the men of Harvey's own standing were never convinced. Questions that were put to an unsuccessful candidate for the Licentiate'ship in 1632 prove that his discovery had not then been accepted by his colleagues. It would be interesting to know if that unlucky candidate was rejected for expressing Harveian doctrines! Harvey himself

<sup>1</sup> Chapter I, "John Caius and the Revival of Learning", *Proc. R. Soc. Med.*, 35, 61.

Sector" in the ensuing scar. A surface application would suffice, and if it were within 14 mm. of the limbus the ensuing defect in the visual field should not be large.

(3) *The treatment of gross hæmorrhage.*—The clearing of vitreous hæmorrhage is uncertain if the hæmorrhage is very gross. The clearing does not seem to depend on age, for I have noted an improvement of vision from hand movements to  $\frac{6}{18}$  in three weeks in a woman of 67 years who showed a mild degree of hypertension. At other times, though absorption may be delayed, there is still hope until six or seven months have elapsed.

Organization of vitreous hæmorrhage by endothelial proliferation frequently does occur, and the pathology of formation of blood cysts in the vitreous was recently demonstrated by Wolff before the Ophthalmological Society of the United Kingdom. Once these fibrous walls and bands have developed, they will remain, and indeed detachment of the retina is known occasionally to result.

In the present series I have used the operation of vitreous aspiration on one occasion only, with a resulting iritis and detachment of the retina; however, in the treatment of traumatic vitreous hæmorrhage, it is certainly useful. With a preliminary surface diathermy at the site of the puncture, the danger of hæmorrhage is reduced, whilst detachment should not occur if the puncture is made at the "site of election", namely the pars plana, at a point 6.5 to 7.5 mm. from the limbus.

With such precautions, in the treatment of vitreous hæmorrhage from pathological causes there should also be some improvement.

Points in favour of aspiration:

(1) It removes a small quantity of blood-stained fluid and thereby starts a fluid traffic in the stagnant gel; fluid comes in from the capillaries and ocular fluids to make good the loss.

(2) Early removal of the blood cells may reduce a stimulus to endothelial cell proliferation and so may inhibit a retinitis proliferans.

Against aspiration:

(1) Reduction of intra-ocular pressure may cause a recurrence of hæmorrhage. This is more likely to be a sequela in pathological than in traumatic hæmorrhage.

(2) Damage to the condensation layers and intimate structure of the vitreous is likely to accrue. This is undoubtedly true, but the pathological changes resulting from the presence of hæmorrhage itself are likely to be deleterious to the gel.

(3) Detachment of the retina is likely to be caused. This operation should be avoided in eyes predisposed to detachment such as those of myopes and people of advanced years.

As an alternative to aspiration Weve (1939) has suggested diathermic puncture of the sclera following a local surface coagulation; if necessary a certain amount of fluid can be sucked out or pressed out. It is indicated after traumatic or operative hæmorrhage, and in vitreous opacities due to chronic inflammation. In the latter Weve has known vision to clear in one week from  $\frac{6}{80}$  to  $\frac{6}{9}$ . I intend to try it on a suitable case, for if it is successful in removing fluid, it is probably less dangerous than aspiration.

Other methods of treatment for the clearing of severe hæmorrhage are:

Short-wave diathermy: I have not seen any improvement by this method.

Subconjunctival or retro-orbital injection of hypertonic saline. Probably of no value whatever, except for psychological reasons.

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DISPUTATIO MEDICA  
INAUGURALIS,

DE

# Morbo puerili Anglorum, quem patrio idiomate indigenæ vocat

*The Rickets,*

QVAM

Deo supplicat ferente,

*Ex auctoritate Nobilissimi Domini Rectoris Magnifici,*

D. JOHANNIS POLYANDRI A KERCHOVEN

SS. Theologie Doctoris, ejusdemque Facultatis in Illu-  
strissima Acad. Lugd.-Bat. Professoris primarii,

Decreto Illustrissima Facultatis Medice, & Amplissimi Senatus  
Academici consensu,

Pro Gradu Doctoratus, summiſſique in Medicinâ Privilegiis  
consequendis,

*Disputandam proponit*

DANIEL WHISTLER, Anglo-  
Saxonicus-Orientalis.

*Add diem 18. Octob. Horis 6 loco confutæ.*



LVGDVNI BATAVORVM.

Ex Officina

WILHEMI CHRISTIANI BOXII. 1645.

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*Ob desitum exemplarium novis typis conservandas  
hujus Thesis Auctor voluit.*

Londini, Ex Typis Thomæ Fleisher, 1684.

said his discovery "mightily diminished" his practice and that no one over 40 at the time he put forward his discovery accepted it. The first man of any distinction to accept it was Francis Glisson, who was 31 when *De Motu Cordis* was published.

Glisson was a slow starter nevertheless. Born at Rampisham in Dorset in 1597, he did not enter Caius College, Cambridge, of which College he became a Fellow and Lecturer in Greek, until he was 20. He does not appear to have started the study of medicine until just after his incorporation at Oxford when he was already 30 years of age. So the seed of Harvey's discovery fell on an open mind uninfluenced by tradition. There is no record of his going abroad to study; he graduated M.D. at Cambridge in 1634 when he was 37, and was elected F.R.C.P. the following year. He must have distinguished himself quickly after his delayed start, for in 1636 he succeeded Dr. Ralph Winterton as Regius Professor of Physic. Winterton, who died at the early age of 36, after only one year's tenure of office, was more of a scholar than a physician, but proved very scrupulous in the discharge of his duties.

In my previous chapter of Cambridge Medical History, *John Caius and the Revival of Learning*, it was not difficult to correlate the man and the University, so close was his association with it. But Francis Glisson, though he held high office at Cambridge for 41 years, was largely an absentee from it. Although the Regius Chairs at both Universities had been founded by Henry VIII just under a hundred years before Glisson's appointment, he was the tenth occupant. Yet when I was appointed nearly three hundred years later there had been only nine other occupants in the interval.

Glisson appears to have lectured and conducted dissections in his earlier years of office. He was Anatomy Reader at the College of Physicians in 1639 and delivered the Goulstonian Lecture there in the following year.

At the outbreak of the Civil War he left Cambridge for Colchester where he made a great reputation. He was there during its memorable siege by the Parliamentary forces in 1648 and was selected on more than one occasion to sue for favourable terms from Lord Fairfax. By 1650 he was certainly established in London, and in that year published his famous work on rickets.

It is often stated, no doubt correctly, that this was a rediscovery, for the disease was prevalent in Rome in the first century A.D. and was described by Soranus of Ephesus, though not named. It would appear doubtful, however, whether it was clearly distinguished from other bone deformities of childhood. According to Still, the nearest approach to any previous detailed description was one by Hieronymus Reussker of Basle, in 1582. Claims are made also on behalf of Arnold Boet's account published in 1649. The name "rickets" seems to have been first used about 1625. The O.E.D. gives its origin as doubtful, and states that Whistler took it to be a corruption of the Greek *παγίς*. This is surprising, for in Whistler's thesis he states that the name was taken from that of a Dorset quack who professed to treat the condition. The word rickety was certainly derived from the name of the disease, and not vice versa, as might have been imagined. Its earliest use was not until 1738.

Whatever its origin, the word rickets first appears in a Bill of Mortality for 1634 as accounting for fourteen deaths, the number from that cause increasing year by year until 1659 when the surprising figure of 476 out of less than 15,000 burials, or 3% of total deaths, is recorded. However, as Muirhead Little pointed out, the causes of death were reported by ignorant women searchers so that these figures can only be accepted with reservations. Nevertheless, there must have been a striking increase in the incidence of the disease about the time of the Civil Wars, and the strongest grounds for believing this is that, more than five years before Glisson's book was published, the College of Physicians was seriously perturbed about it, and a collective investigation by seven Fellows was started. They were members of a private society and communicated their ideas to one another. The resulting observations were to be compiled by three of their number, Glisson, Bate and Regemorter. The first plan was for each to write a section. But Glisson was found to have done so much more, and also to have had ideas peculiar to himself, so the other two asked him to bring the book out: he consented, but courteously requested them to allow him the advantage of their criticism and observations. In view of claims of priority that have been made for Whistler it should be noted that the preface specifically states that Glisson had been at work on the subject for more than five years. As Sir Norman Moore observed: "The whole was done without secrecy, within the possible knowledge of all the Fellows, and these seven physicians communicated with one another with all the liberality that distinguishes true members of the republic of learning."

been found guilty, and still less can one convict a man for a previous offence because he committed one subsequently. Yet Whistler's subsequent peculation of the funds of the College of Physicians has naturally, if illogically, influenced the making of this charge of plagiarism.

Whistler seems to have been a man of charming manners and considerable address: Pepys said he was good company, and Evelyn described him as most facetious. But he was a happy-go-lucky, conscienceless type with very little conception of duty or honour. He had a lucrative practice and married a rich widow but died, nevertheless, in debt. He systematically neglected his work as Registrar of the College and left its Annals in "perplexing and inextricable confusion". Why a man with such a record was made Treasurer, it is difficult to imagine, or why "in an evil hour", as Munk puts it, he was finally elected President in 1684. When he died during his year of office he was found to have taken advantage of his position to defraud the College, but in what manner and to what extent is not recorded. It was, however, regarded at the time as a disgraceful affair. He must have been of the well-known type who speculates trusting to luck that he will be able to put things right before the audit. Whether he would have done so, or been able to, we shall never know. Certainly he had not the chance, for he died speedily of a malignant type of pneumonia.

Yet he had been an important man in his time. He corresponded with Oliver Cromwell and showed himself an acute politician. He was elected F.R.S. in 1663 and held all the high offices at the College, including that of Harveian Orator in 1659. Sir Frederick Still's kindness of heart leads him to doubt the validity of the charge of peculation, but in view of the clear statement in the Annals that Sir John Cutler, previously a benefactor of the College, reimbursed it in whole or part, Whistler's innocence can hardly be maintained. Nevertheless, the College that went on electing him to positions of responsibility because of his ingratiating ways cannot be held free from blame. There is a pleasing portrait of him in the College, "in company too good for his deserts".

Glisson's account of rickets ran to 416 pages and though we are not impressed with his views on its therapeutics, in other respects as Sir Humphry Rolleston says little more was added to it until the discovery of vitamins. His merits as an orthopaedic surgeon were discussed by Mr. Muirhead Little before this Section in 1926. His next famous work on the Anatomy of the Liver appeared in 1654, and the description of Glisson's capsule is imprinted on the memory of every medical student. This was followed by a philosophical treatise, *Tractatus de Natura Substantiæ energetica*, which was published in 1672 and contained an anticipation of the theory of muscular contraction. Four years later came the *Tractatus de Ventriculo et Intestinis*. All these books were reprinted several times. The Sloane Collection at the British Museum contains twelve volumes of his MSS., including letters, prefaces, and lecture notes.

He never returned to reside in Cambridge after the Restoration, but merely went there for the keeping of the Acts. Yet this did not deter him from appealing successfully for the receipt of back pay for duties he did not perform. Consciences concerning sinecures were not very active till the nineteenth century. For the last two years of his life Nicholas Brady acted as a deputy and became his successor. To his credit be it said that he stayed in London during the Great Plague of 1665 when so many physicians fled with their well-to-do patients. As Dekker remarked of the earlier epidemic in 1603, "Never let any man aske me what became of our phisitions in this massacre—they hid their synodical heads as well as the prowdest. Galen could do no more than Sir Giles Goosecap".

Glisson took an active part in the life of the College of Physicians while in London, as he had previously done while still residing in Cambridge. He became an Elect in 1655, Censor in 1656, Councillor several times, and was President for the three years 1677-8-9. He was also one of the small, but distinguished, group who initiated a weekly meeting in London to promote research in natural science; this, as we know, was the parent, after the Restoration, of the Royal Society, of which he naturally became an original member. He died on October 14, 1677, aged 81, at his house in New Street, Shoe Lane, and was buried in St. Bride's, Fleet Street. Thus terminated a great career, rich in achievement.

It was an unfortunate thing for natural science and medicine at Cambridge that for so many years Glisson was an absentee. It cannot be claimed that the Regius Professors of Physic played an important part in science or medicine prior to the nineteenth century,



The first edition appeared with the imprimatur of the Censors of the College of Physicians in 1650, as already stated, and in the next year an English translation by Philip Armin was published. A third edition was printed at Leyden with a frontispiece representing various rickety deformities. In 1668 the notorious Nicholas Culpeper, now the patron saint of the herbalists and a consistent enemy of the College of Physicians, had the audacity to publish an English edition which, he claimed, was "enlarged, corrected and very much amended", but, as Muirhead Little found, the number and size of the pages are the same, and the page on which each chapter begins is also unaltered, so there cannot be any enlargement, and he could not discover either amendment or correction.

We now come to the consideration of the claims for priority that have been put forward on behalf of Daniel Whistler, a probationary Fellow of Merton College, Oxford, who went to Leyden in 1642 to study physic. He returned to Oxford to take his M.A. in 1643-4, and then went back to Leyden where he presented a thesis for his M.D., *De morbo puerili Anglorum* "commonly called the rickets". As this was in 1645, his essay preceded Glisson's elaborate account by five years. He published another edition in 1684, the year of his death, and at one time Dr. Samuel Gee and Dr. Norman Moore (as he then was) doubted whether the thesis of 1645 was ever printed, which would have made the claim for priority still more dubious. However, in November 1883 Munk, then Harveian Librarian at the College of Physicians, found a printed copy dated 1645 which had got into the back of one of the deep, narrow cupboards. About that same time a new British Museum catalogue was made, which led to the finding of another printed copy: this Norman Moore compared and found identical with the copy in the College.

There can, therefore, be no doubt that Whistler published the first account of rickets, and under that name. We may next consider, was there either deliberate plagiarism or was his work based on his own observations? Sir Frederick Still took a very kindly view of this; after stating the seventeen diagnostic points enumerated by Whistler, he goes on to say, "as a clinical description this seems to me a concise statement of most of the facts and such a picture as any unbiassed critic would judge to have been drawn from personal observation", though he admits there are no post-mortem descriptions and the pathology is purely speculative. He further urges that, as Whistler was in Leyden most of the time, he would not have had much opportunity of plagiarism. But that is a double-edged argument. What opportunity had he of making observations on the *Morbus Anglorum* at Leyden? What opportunity would he have had during his brief return to Oxford to make out those seventeen diagnostic points? Surely it is more probable that he became aware of the researches then going on and was impressed with the interest they would arouse in Holland. We can hardly expect the description of a new disease in an M.D. thesis—though Still himself succeeded in doing this—nor can we demand great originality. Even to-day a careful collection of evidence may be regarded as sufficient. And it should be noted that Whistler alludes to suggestions of other authorities on the disease and to the views of one especially learned man, which seems to hint at Glisson. Indeed, he himself lays personal claim to but one thing—the invention of a scientific name for the disease—and that the terrible one of *Paedosphynchrosteocaces*—in which, fortunately, no one has followed him! To quote Norman Moore:

"Whistler makes no claim in his thesis to be the discoverer of rickets. It would have been useless, had he wished it, to make any such claim at a time when so many of the most active medical minds in London were discussing the subject and when an elaborate work on it was in actual preparation. . . . There is a vagueness about the whole essay, an absence of facts and a redundancy of theory. . . . There is no history of controversy about priority in Glisson's lifetime."

Glisson's book bears in every part the marks of originality and patient observation, with full post-mortem descriptions. Indeed Still admits Whistler's account lacks the picturesque fullness of detail which suggests the eye-witness, but says one would hardly expect much of this from a young man who had only just finished his university study and had not as yet engaged in practice. Nor, one might add, could it be expected, under such conditions, that his essay was original.

The conclusion seems to be that, while there is no real claim to priority, there was no wilful plagiarism with intent to deceive, but an account was given by a young graduate of an interesting piece of work that was going on in England which he proudly christened in a highly euphuistic strain. I have very little doubt that the bad odour in which Whistler has been held was based on his later history. It is an established legal principle that previous convictions cannot be quoted against a defendant unless and until he has

a system of passes, and the military occupation of Cambridge interfered with University life considerably less than the occupation of Oxford by the King which virtually put an end to all the University activities there. In the earlier stages of the Civil War, at any rate, conditions were fairly normal and students proceeded to take their degrees. The concern of the Parliamentary party on behalf of Cambridge is also shown in a House of Commons order, promulgated in March 1642-3, forbidding outrage or violence to scholars or to buildings and the plundering of books, goods or chattels. There is no ground for the statement in *Querela* that the military authorities in Cambridge abused their power by searching every College, examining every scholar, and thoroughly plundering. In the following January the House of Commons issued another declaration that estates, rents and revenues belonging to Colleges and Halls should not be sequestered for any delinquency on the part of Heads of Houses, Fellows or Scholars. Further, they were exempted from taxation. This, however, did not apply to the tenants of College property, and it was one thing to be allowed to collect rents and another to be able to get them. Although the Earl of Manchester, on his visitation, enforced the taking of the Covenant on all over 18 and took steps to get rid of those who "opposed the proceedings of Parliament", the members of the University were exempt from being impressed into military service, though many of them joined either army as volunteers.

It may seem surprising that Parliament tolerated the presence of a strong Royalist element for so long after the outbreak of war. Probably the Eastern counties were so strongly Parliamentary at heart that this toleration presented no danger. Even so, the Masters of twelve out of the sixteen Colleges then existing were removed from office, and the Old Court at St. John's was turned into a concentration camp into which suspect Fellows who continued to reside were put and kept under surveillance. But there was no such wholesale commandeering of Colleges as took place at Oxford. Naturally, in common with all owners of property, the University suffered financially very severely from the effects of civil war, but it is quite clear on all counts that Cambridge suffered far less severely than Oxford, which, not for the last time, had become the home of a lost cause. Accordingly, we cannot refer Glisson's departure from Cambridge to the disturbed condition of academic studies. He was a Presbyterian, so that he would not have been disturbed by the Parliamentarians. It is more probable that he did not find the atmosphere of the University favourable to natural science. Yet there was intense intellectual activity, largely stimulated by Henry More who entered Christ's College in 1631, some six months before Milton left it.

We know that Milton described his academic studies as "an asinine feast of sow thistles and brambles", but Henry More and his fellow-Platonists changed all that, and a few years later "Cambridge men were deep in Descartes and some of them in Bacon". A new intellectual life sprang into being and the heaven spread as the Platonists were appointed to responsible positions throughout the University. Apart from More, the others, of whom I need only mention Whichcote, John Smith, Cudworth, and Culverwel, were all trained at Emmanuel. I cannot enter the courts of that College without feeling that something of the cool, restraining influence of those Platonists haunts them still. They should be living at this hour. England has need of them. Peace be to their ashes, for in their lifetime they diligently sought and ensued it.

Of the active intellectual life in the Cambridge of their day a vivid picture is drawn in Miss Rose Macaulay's brilliant, but unfortunately named, novel, "They Were Defeated". But we must admit it was not favourable to science. It is true that John Ray (1627-1705), the father of natural history in this country, published his first work in 1660 while Steward at Trinity College. This was an account of the flora round Cambridge, but the rest of his great work was done after he had left the University altogether. Wallis, as we have seen, migrated to Oxford, followed eight years later by Millington of Trinity who afterwards became President of the Royal College of Physicians. Then there was Seth Ward, afterwards Bishop of Exeter and later of Salisbury. A lecturer at Sidney, he was appointed in the same year as Wallis to another Savilian professorship at Oxford, that of Astronomy. Instances not uncommon at the time, as Shipley says, of men educated at Cambridge but recognized and promoted at Oxford. Harvey's retreat to Oxford rather than a return to his old University after Edgchill may well have been necessary for the physician to King Charles, but it is obvious that all these men must have found a haven indeed at Oxford amid such a galaxy of talent and genius that centred round Williams, the Warden of Wadham. Here they could meet such men as Christopher Wren, Robert Boyle, Hooke, Bathurst, Lower, Mayow, and Thomas Willis, the Oxford branch of that "Invisible Clubbe" which, as we know, was a nucleus of the Royal Society.

but Glisson, with his interest in aetiology and morbid anatomy, might well have been able to do so. Indeed, we know that he stimulated John Wallis to promulgate Harvey's discovery in a public disputation, presumably for his degree which he took a year after Glisson was appointed. This John Wallis (1616-1703) was the famous mathematician who entered Emmanuel College in 1632 where he was a foundation scholar. He subsequently became an associate of Boyle's and, in 1649, was appointed Savilian Professor of Geometry at Oxford. His mathematical writings were the most stimulating that had appeared in England up to that time and Isaac Newton records that, as an undergraduate, he read them with delight. If Glisson could pick out a man like that, one cannot help feeling that if he had remained an active teacher in the University his encouragement and discernment might have detected some others who remained mute, inglorious, or who fled.

The actual conditions obtaining in Cambridge during the Civil War seem hardly to have justified Glisson's departure. Fuller, in his history of the University, says that the smoke only and not the fire of the war reached Cambridge. Certainly Glisson found himself plunged into that fire by moving to Colchester, as we have seen. Many of the sufferings of Royalists in Cambridge discussed in *Querela Cantabrigiensis* are mythical. This compilation was written up in Oxford by Bruno Ryves of Magdalen from material supplied by John Barwick, a Royalist of St. John's College, Cambridge. But as Barwick had left Cambridge before the occurrence of the events he professes to describe he could have had no first-hand knowledge of them. Varley, after a careful analysis of its contents, concludes that as evidence the *Querela* must be relegated to a very low category.

The defence of Cambridge was, throughout the Civil War, the special care of Oliver Cromwell, to whom both town and University were much indebted. He was educated at Sidney Sussex College and appears subsequently to have gained much popularity in Cambridge by the support he gave to the Earl of Bedford over the construction of the Bedford Level to prevent the Ouse from overflowing the fens, in opposition to the plans of the Crown. Yet he was a comparatively unknown man when elected as one of the two members for the borough of Cambridge to the Long Parliament in 1640, although he had previously sat for Huntingdon. In view of the extraordinary military ability he displayed later, it is remarkable that, up to the time he undertook the defence of Cambridge in 1642, there is no evidence that he had had any military training or experience. The King's application in June 1642 for money at 8% interest met with a very meagre response from Cambridge, only £635 being subscribed, £285 of which came from private contributions. Instead there was a response of a different kind in the raising of a volunteer force for which Cromwell sent down arms. This was followed by another application from the King within a month—this time for College plate. As Cromwell was residing in Trinity and as Cambridge had been virtually in the hands of the rebel forces since the previous March, who were well informed as to the intention of certain Colleges to assent, it is not surprising that not much got away. Three Colleges, St. John's, Jesus, and Queens' succeeded in this, while the contribution from Magdalene was intercepted on the road to York. Despite the statements of certain historians, the plate did not fare badly at the hands of the rebels either. Certainly Oxford suffered more in this respect at the hands of the Royalists.

Soon after the King opened hostilities by raising his standard at Nottingham, Lord Capel threatened a raid on Cambridge and Cromwell fortified it, using the material accumulated for re-building Clare, a work carried out after the war with beautiful results. He also demolished the bridges at St. John's, Trinity, Garret Hostel, King's, and Queens', all of which were merely wooden structures except King's which had had a stone bridge erected as recently as 1635. Thus only the main town bridge remained, and this was dominated by the Castle.

Much has been made of the damage done by Parliamentarians, but since Cromwell had such a tender place in his heart for Cambridge this seems *a priori* unlikely and is disproved by the facts. It is true that Dowsing, acting under the orders of the Earl of Manchester, defaced the stained glass in three Colleges, Peterhouse, Clare and Magdalene, though the lovely fourteenth century Flemish east window in Peterhouse Chapel must have been spared. The splendid Renaissance glass in King's College Chapel was not damaged throughout the occupation by Parliamentary troops, although they actually paraded there. A much more serious, and less advertised, cause of destruction of church interiors was the practice of temporarily housing prisoners of war there.

Members of the University seem to have been relatively free to come and go under

## Section of Neurology

President—R. M. STEWART, M.D.

[October 15, 1942]

### Observations on the Pathology of Cerebral Diplegia (*Abridged*)

#### PRESIDENT'S ADDRESS

By R. M. STEWART, M.D.

DIPLEGIA is one of the commonest causes of crippling in children.

Collier (1924) did not denote the types of cases to be admitted under the title "Cerebral Diplegia", but it is clear from his address that his conception of diplegia embraced conditions of bilateral spastic weakness, congenital or acquired, both progressive and non-progressive and of all degrees of severity, ranging from generalized rigidity of the four extremities to the mildest cases which show only slight spasticity of the legs.

Sachs (1926) regards the exact form of the paralysis as relatively unimportant. In his view, it is of more practical value to group the various cases according to their time of onset and to the morbid lesions which have been found to be the chief cause of one or other forms of paralysis. But in making this choice the difficulty arises that very often we have only the history of the case to guide us, and important facts relevant to the condition may have become forgotten in the course of time.

Moreover, since the normal activities of the newborn infant are probably all reflexes mediated by the brain-stem and spinal cord, signs of pyramidal involvement are seldom evident at birth and, hence, separation of the congenital from the acquired types of cerebral diplegia will often be a matter of some difficulty. Frew (1936) states that, of sixty-two cases of cerebral birth palsy, fifty-two showed no sign of paralysis at birth. Stiffness of the limbs not appearing until between the second and fourth month after birth. In my series of fifty cases, wholly satisfactory histories were seldom obtained but there was reasonable evidence of a congenital or early post-natal origin in all but five.

[For further discussion on cases of diplegia the reader is referred to the bibliography.]

Before discussing the pathological changes which may be encountered in the diplegic's brain, a few words may be said about current views on their mode of production.

#### PRIMARY DEGENERATION OF THE CEREBRAL NEURONES

Collier lent all his eloquence and weight of authority to support the theory that primary neuronal degeneration is the essential cause in all cases of diplegia whether, incident in foetal life or in childhood. From the pathological material available, he deduced that the morbid process begins long before birth and is in no way related to birth injury or meningeal hæmorrhage. The arrest of neuronal development he compared to the blighting effect on germinating seeds of a frost which, according to the severity and time of arrival, causes an interference varying from complete death and destruction to retardation and stunting of growth. The nature of this frost affecting the neuroblasts is unknown. In support of his view, Collier stressed the following points: The remarkable symmetry of both the paralysis and the atrophy and sclerosis of the motor convolutions. The lack of correspondence between the degree of atrophic lobar sclerosis when present and the severity of the clinical picture—the paralysis may be severe and the atrophic sclerosis slight. The presence in some cases of atrophy of pyramidal cells out of all proportion to the shrinkage of convolutions—some of the severest cases of prenatal diplegia having no gross lesion at all. The presence in amaurotic idiocy of a ubiquitous degeneration of ganglion cells unaccompanied by sclerosis, this disease being considered by Collier to belong to the general class of diplegias. The occurrence of optic atrophy in many cases of diplegia. The occurrence of familial diplegia, including instances where one child is diplegic from birth and the other siblings healthy until the onset of paralysis in the early years of childhood; the close resemblance of the symptoms of congenital and postnatal cases. The implication of the cerebellum in one case of congenital diplegia described by Anglade and Jacquin (1909). The failure to discover even the most slender causal antecedents in 40% of all cases, and, lastly, the difficulty of referring one and

Still, a University that produced Gilbert, Bacon, Harvey, Glisson, and Newton within a century need have little cause for shame. William Gilbert, who was a Fellow of St. John's and President of the Royal College of Physicians, published his great work on the magnet and terrestrial magnetism in 1600, the year of Giordano Bruno's cruel martyrdom. Charles Singer remarks: "The universe of Gilbert is that of Bruno . . . Gilbert must have met Bruno at Elizabeth's court probably in the company of Sir Philip Sidney." The faggots that consumed Bruno's body lit such a candle, to apply the declaration of another martyr, as could not be put out, for his spirit changed cool intellectual assent into a flaming passion for the discovery of new truth in many minds. For, to quote Singer again:

"That hideous event was the herald of a period that has no rival for the number and importance of its scientific discoveries. A glance at the mass of fundamental scientific work of the seventeenth century shows the major departments becoming clearly differentiated. The acceptance of observation and experiment as the only methods of eliciting the laws of nature reaches an ever-widening circle. The very first scientific generation of the century saw the development of a mathematical technique that became the instrument of the new discoveries."

Mathematics, being abstract, have the advantage of not being dependent on other sciences, in the way that physiology depends on physics and medicine on psychology. On the contrary, as Singer says, they become the instrument and, one might add, a measure of the accuracy of new discoveries. Thus they assumed the lead. S. C. Roberts tells us that John Wallis, that great precursor of Newton, migrated from Emmanuel to Oxford because he found "mathematics were scarce looked upon as academical studies" at Cambridge. This no doubt accounts in some degree for the comparative backwardness of science there during the insurgent century. Yet such science as there was showed a bias towards the mathematical and physical, for the century that opened with Gilbert closed with Newton, and Harvey's great work involved the application of physical principles to physiology. Glisson remains the outstanding exemplar of biological principles in that age—he raised clinical observation and morbid anatomy to an altogether new level.

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If we adopt this conception of the relationship of myelinization to the development of motor function we are pursuing a theory which has some affinity with that advanced by Brissaud (1894). It may be recalled that he emphasized the not infrequent association of prematurity with the paraplegic forms of diplegia and avowed that birth before term arrests or retards development of the pyramidal tracts which, under normal conditions, are pictured as growing out from the cortex from the fifth month onwards. In an infant born at six months the tracts will not have developed below the medulla and the child will be diplegic; in an infant born between the eighth and ninth month the tracts will have reached the cervical region; in such a case, only the lower extremities will be deprived of their regulatory influence, and thence arises a paraplegia. His theory is open to obvious objections. In the first place, the immense majority of infants born prematurely do not suffer from paralysis nor is the proportion of diplegic infants born prematurely, large.

Again, though it is true that in the human foetus the process of myelinization follows a definite pattern, it has not been established beyond dispute that the deposit of myelin is coincident with the development of function in the neuron. Nor does recent research suggest that this phase of maturation proceeds in such an orderly cephalocaudal manner. Orthello Langworthy (1932) has shown that in the human foetus of six months there is a considerable amount of myelin in the cervical region of the spinal cord though at this time there are no medullated tracts rostral to the midbrain. He claims that the process of medullation extends from the medulla in a cephalic direction and it is not until the second month of postnatal life that myelin is found on fibres beneath the cortex. In the cord the spread of myelinization is from the cervical regions downwards.

#### ASPHYXIA AND ANOXÆMIA

Though eighty years have elapsed since the appearance of Little's classical paper in which he stated "capillary apoplexies are the cause of general spastic rigidity" there is still no unanimity of opinion on this problem. Obviously, during its progress through the birth canal the foetus undergoes special risks to its vital oxygen supply and these are increased by various accidents or incidents common in parturition. Asphyxia is inevitable when the cord is compressed as may happen in the course of podalic version and is common in breech presentations but these factors are too inconstant to afford a reasonable explanation of the origin of diplegia.

Stress has lately been laid on the possible part played by oxygen want. Such varied conditions as carbon monoxide poisoning and nitrous oxide anæsthesia are known to exercise the gravest effects on the central nervous system and, in particular, on the cerebral cortex and basal ganglia. Brander (1940) records an instructive case of a pregnant woman who attempted suicide by carbon monoxide poisoning. When seen at the age of 4½ years, her offspring was an idiot with spastic quadriplegia.

Courville (1938) has drawn attention to the special risks of nitrous oxide gas when used for the induction of anaesthesia in the second stage of labour. According to Schreiber (1938) the use in parturition of sedative drugs such as the barbiturates may so heavily narcotize the newborn infant that its respiratory centre is depressed to the point of producing anoxæmia.

Faber (1942) claims that insufficient attention has been paid to the possibility of anoxæmia occurring in earlier periods of gestation. Among the conditions which may interrupt the foeto-maternal circulation he mentions degrees of placental separation, placenta prævia, attempts at abortion, the toxæmia of pregnancy—itsself a recognized cause of placental separation—and congenital syphilis which may cause placental changes sufficiently severe to interfere with normal oxygen supply to the foetus. In a case of cerebral atrophy in Frew's series, maternal pneumonia during pregnancy appeared to be a factor of importance.

That the effects of oxygen want are especially injurious to the nervous system is clearly indicated by experimental work on animals by Gildea and Cobb (1938), Weinberger, Gibbon and Gibbon (1940), Thorner and Lewy (1940).

A few words may be said about the pyramidal tracts whose involvement is held responsible for the cardinal feature of this syndrome. It has become an almost ineradicable belief that in all mammals the pyramidal fibres are derived exclusively from the giant cells of Betz in the fifth lamina of the precentral convolutions. This belief rests largely on the observation that the anatomically conspicuous Betz cells exhibit a retrograde chromatolysis when the fibres of the pyramidal tracts have undergone transection or damage in some part of their course, but we cannot assume that the axons of small nerve cells do not share in the response to injury of the pyramidal tract, for such cells do not ordinarily show chromatolysis.

Campbell (1905) estimated the number of Betz cells in each precentral convolution to

the same pathological condition to such widely different causes as premature, precipitate and prolonged birth and to asphyxia.

All gross lesions, according to Collier, are an accidental accompaniment and he concludes that the evidence demands that meningeal hæmorrhage should be deleted as a causal factor of any infantile spastic state.

Great importance was, at one time, attached to the communications of Dr. Sarah McNutt (1885) who made the generalization that meningeal hæmorrhage is the usual cause of spastic states dating from the time of birth. A case of cerebral diplegia which showed bilateral cortical atrophy did much to strengthen her in this belief.

There can be little doubt, however, that McNutt misinterpreted her observations. In the first place, she failed to show that subarachnoid hæmorrhage could cause cerebral diplegia, for her two patients in whom she found hæmorrhage were not diplegic; and, secondly, she failed to establish any relationship between subarachnoid hæmorrhage and the pathological condition described by the two pathologists who examined her material.

It is, of course, not disputed that subarachnoid hæmorrhage is a frequent finding in infants' brains. Extensive extravasations are often found in infants dying within a few days of birth but such cases afford no proof that lesions of similar magnitude exist in infants that survive. Nor is it disputed that approximately 12% of all newborn infants exhibit blood in the cerebrospinal fluid, but the ultimate fate of such cases is unquestionably favourable and, even in those in which fairly extensive subarachnoid hæmorrhage over the convexity of the brain is found, it seems likely that complete absorption without damage to the underlying cortex is the rule. We know, too, that in the adult, subarachnoid hæmorrhage, if diffuse, may do little damage.

Ford (1926) stated that he had been unable to find a single report of a case of true cerebral diplegia in which the occurrence of an intracranial hæmorrhage at birth was established. Frew (1936) mentions the case of two babies that lived for a fortnight with extensive cortical hæmorrhage but the general condition of the infants was quite unlike what one finds in cerebral birth palsy. The same writer also examined the post-mortem records of seventeen cases of intranatal cerebral palsy. In no single instance was there any evidence of a cortical hæmorrhage, recent or old.

The late results of birth injury have been studied by Roberts (1939). Sixty-six cases of intracranial hæmorrhage due to birth injury were followed up for varying periods of time up to eight years. Forty infants—approximately 60% of the entire group—developed in a perfectly normal way. Only nine, showing both motor disturbance and mental retardation, could be classified as examples of cerebral spastic paralysis. Of four infants with motor disturbance only, two were monoplegias, one a paraplegia and one a case of generalized spasticity. This investigation does seem to suggest that intracranial hæmorrhage is responsible for a certain number of infantile spastic palsies but it does little to advance the view that cerebral diplegia is conditioned in this way.

However, it is not only hæmorrhages of large size which have been assigned an important role in the production of cerebral diplegia. In recent years attention has been focused on the part played by extravasation of microscopic dimension.

Schwartz (1924) was among the first to demonstrate in children, stillborn, or dying during the first six months of life, the frequency of petechial hæmorrhages and minute necrotic areas in the central white matter surrounding the third and lateral ventricles. He stressed the frequency of hæmorrhage, especially in premature infants, in the territory drained by the vena terminalis, the vena lateralis ventriculi and the vena basilaris.

Frew goes further than Schwartz. In his opinion, hæmorrhage in the parts drained by the vena terminalis is responsible for all types of cerebral birth injury, including cerebral diplegia. The parts principally affected are the lateral nuclei of the optic thalami. He suggests that hæmorrhage in this situation, by cutting off the sensory impressions which normally pass through this region, robs the cells of the motor cortex of sensory impulses on which their postnatal development is claimed to depend.

Patten and Alpers (1933) in a study of thirty infantile brains, removed either as a matter of routine or because there was some suspicion of disease, found petechial hæmorrhages in twenty-six.

It is significant that most of the capillary hæmorrhages in these cases were under the ependyma of the ventricles, in the so-called germinal centres, where one finds foci of neuroblasts and spongioblasts destined to become sources of supply for the cortex itself. They suggest that hæmorrhages into the subependymal region destroy the spongioblasts from which the oligodendroglia are derived and so interfere with the capacity of the brain to form myelin. The essential basis of cerebral diplegia is therefore defective myelinization.

Patten and Alpers conclude by stating that the hæmorrhages occur prenatally and that they have no relation to trauma: their cause is unknown.

will be observed that three-fifths of the patients had reached adult life, that all were mentally defective and, with few exceptions, in the ranks of low-grade amentia.

In Chart 3 the total brain weights are shown. It will be seen that fourteen patients

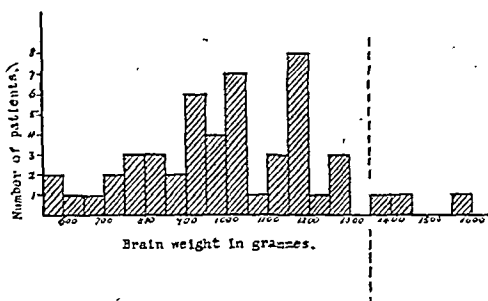


CHART 3.

exhibited a marked degree of microcephaly, while only three reached the average normal brain weight.

#### DESCRIPTION OF LESIONS

TABLE II

##### Macroscopic appearances

Normal appearances	...	...	...	...	9	Cerebellar atrophy	...	...	...	...	5
Atrophic lobar sclerosis	...	...	...	...	6	Developmental anomalies	...	...	...	...	1
Microcephaly	...	...	...	...	16	Optic atrophy	...	...	...	...	2
Micro-hydrocephaly	...	...	...	...	3	Small pyramids	...	...	...	...	12
Cortical atrophy without obvious sclerosis	...	...	...	...	3	Thickening and opacity of pia-arachnoid	...	...	...	...	13
Marked abnormal convolution pattern	...	...	...	...	13	on vertex	...	...	...	...	13

Table II brings out the wide variations in the naked-eye appearances. They include brains which, apart from their undersize, showed no departure from the normal to those which were typical examples of atrophic lobar sclerosis. Ford claims that atrophic sclerosis is the commonest pathological finding in cerebral diplegia. In this series it was present in only six cases.

Rather more than a quarter of the brains showed a marked degree of thickening of the pia-arachnoid, usually most marked in the neighbourhood of the longitudinal fissure. Beneath the thickened membranes the convolutions were usually narrow but seldom definitely sclerotic.

Two of the cases were examples of cerebellar diplegia and in both the cerebellum showed a very marked atrophy. But cerebellar atrophy of a striking degree was also present in three cases of spastic diplegia who, during life, gave no signs of cerebellar involvement. Moreover, milder degrees of atrophy of the cerebellar hemispheres were encountered in a good many other cases, even in microcephalics who usually show a relatively large cerebellum. One other macroscopic appearance calls for remark. In the normal brain the pyramids form two conspicuous rope-like strands on the ventral aspect of the medulla. In the fifty diplegic brains a normal degree of development was seen in ten instances only.

Disturbance of the internal configuration of the cerebral hemispheres was noted in two instances. In one, sclerosis with cavity formation was found in the mesial thalamic nucleus of one cerebral hemisphere and in a second case the appearances were those of status marmoratus.

*Microscopic appearances.*—The wealth of material, now amounting to more than three thousand slides, makes the task of presenting a comprehensive picture of the histological findings one of some difficulty and here it is possible to present only the barest outline.

At the outset it may be said that degeneration of the pyramidal tract was by no means a constant finding. In four cases (8%) no abnormality could be found in any part of the corticospinal path. In these Betz cells were present in their normal number with no evidence of demyelination of their fibres, nor was there any apparent loss of the smaller pyramids in the motor area.

In five cases only was it possible to trace degeneration from the motor cortex through the internal capsule, the peduncles and brain-stem to the lumbar region of the cord. In other cases where abnormality existed, degeneration could be demonstrated only at certain levels. Thus, in twenty-two cases a full complement of Betz and smaller pyramidal cells was present although in more than half marked demyelination of the pyramidal



be in the neighbourhood of 25,000 and more recently Lassek counted rather more than 34,000 in similar areas. There seem to be few exceptions to the histological arrangement whereby large cells possess large fibres and small cells small fibres and on this basis it follows that if the giant Betz cells are the sole source of pyramidal bundles the constituent fibres should be predominatingly large. Yet in the human pyramidal tract the contrary obtains: by far the greater number are fibres of small calibre. Just rostral to its decussation each pyramidal tract contains roughly two-thirds of a million medullated nerve fibres of which nine-tenths can be classified as small; in other words the large fibres derived from the Betz cells are enormously outnumbered and hence it follows that, unless the axons of Betz cells dichotomize extensively before reaching the spinal cord, the greater proportion of pyramidal tract fibres must originate from cells of small size.

In the present state of our knowledge it is not possible to say with any degree of certainty where these cells of origin are to be found. Both Economo (1929) and Fulton (1938) have expressed the view that small pyramidal cells of the precentral areas contribute to the corticobulbar and corticospinal projections.

Here it may be observed that it is by no means easy to decide what exactly constitutes a Betz cell. Size, by itself, affords no criterion. Lassek (1940) found cells with the morphological appearance of Betz cells of a size varying between 900 and 4,100 sq.  $\mu$ ; the diminutive type predominated in all regions of the motor cortex while 75% of the giant cells were congregated in its upper third. Giant cells may also be found in the posterior parts of the second and third frontal convolutions.

It seems evident that, if the fibre content of the pyramidal bundles receives a substantial contribution from the immense number of small pyramids, their implication in the upper motor neurone disease could only be demonstrated by making serial sections of the entire motor cortex with counts of the ganglion cells in at least three laminæ and a task of this magnitude has yet to be attempted.

A review of the voluminous literature of cerebral diplegia conveys the impression that speculation on its pathogenesis has outstripped the concrete task of examination of pathological material. Yet, obviously, assembly of pathological data should precede speculation. Here it must be confessed that the reports of the last century are of limited value, many of them being concerned solely with macroscopic appearances while others dealing with microscopic findings labour under the handicap of inadequate histological methods.

#### MATERIAL FROM LEAVESDEN HOSPITAL

The present study is based on material derived from diplegic aments. In the series are fifty brains and thirty spinal cords. Table I gives an analysis of the clinical types included in the series.

TABLE I

Cerebral diplegia	...	...	...	...	...	...	36
Cerebral triplegia	...	...	...	...	...	...	3
Cerebral quadriplegia	...	...	...	...	...	...	4
Double athetosis	...	...	...	...	...	...	5
Cerebellar diplegia	...	...	...	...	...	...	2
							50

Four patients exhibited congenital syphilis, in one tuberculous sclerosis accompanied the diplegic syndrome and in six there was a familial incidence. The ages of the patients at death and their distribution according to mental age are given in Charts 1 and 2. It

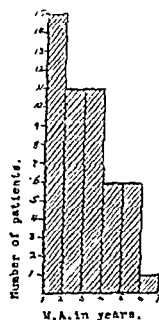


CHART 1.

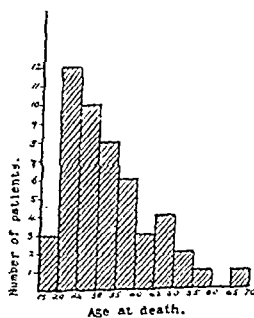


CHART 2.

roughly one-third were epileptic, but normal Purkinje cell counts were the rule, except in the brains from diplegic cases. Forty-four per cent. of my diplegic patients were epileptic but the loss of Purkinje cells bore no constant relationship to the presence or absence of convulsions and it would seem, therefore, that the presence of epilepsy cannot afford a satisfactory explanation of the frequency of these changes.

The possibility that anoxæmia plays some part in their production is suggested by the animal experiments of Gildea and Cobb (1938), Weinberger, Gibbon and Gibbon (1940), Thorner and Lewy (1940) which give convincing proof of the disastrous effects of oxygen want on the cerebral and cerebellar cortex. Changes varying from minute patchy areas of cell loss to larger areas of cortical destruction are typical findings in cerebral anoxia while in the cerebellum the Purkinje cells are hardly less susceptible.

Now, as we have seen, these changes are frequently encountered in the brain of the diplegic and though similarity of lesions is not a sound basis on which to build claims for identity of cause, the hypothesis of cerebral anoxæmia operating at or before birth would appear to offer a reasonable explanation of the pathological findings in certain cases of cerebral diplegia.

To suggest the hypothesis that nutritional deficiency may help to explain the origin of cerebral diplegia is to theorize entirely beyond the known facts, yet the lesions I have described have so many points of resemblance to those observed in avitaminosis that the following comment seems permissible.

In the first place, attention may be drawn to the undisputed fact that in the past a not inconsiderable proportion of the population of this country lived on the borderland of vitamin insufficiency and that clinical experience has shown that many of the disturbances so common in the early stages of pregnancy are almost certainly due to a low level of maternal nutrition.

Secondly, recent experimental work on the effects of vitamin deficiency has indicated that many of the lesions produced have the distribution and character of those described in cerebral diplegia. Swank and Prades (1942), for example, have shown that thiamine deficiency exercises its effects first on the distal part of the axon with myelin changes secondary to these, that degeneration proceeds centralwards, that large nerve cells and large nerve fibres degenerate first, presumably because their metabolic needs are greater and they are therefore more susceptible to nutritional deficiency, that marked degeneration is found in the cerebellum and, lastly, that widespread hæmorrhages of small size are present in regions containing degenerating neurones.

Thirdly, a study of the lesions in demyelinating diseases in man and animals indicates that many of these have their counterpart in the diplegic's brain. We have already seen that in cerebral diplegia disappearance of the large cells of Betz is inconstant and there may be apparently complete absence of demyelination at cortical, capsular or peduncular levels when obvious sclerosis is evident in the brain-stem and spinal cord. As Davison (1941) has shown, this peculiarity of distribution is shared by amyotrophic lateral sclerosis: in about two-thirds of the cases the giant cells of Betz are spared and degeneration of pyramidal tracts may not become visible until the pons, the medulla or even the spinal cord is reached. The ætiology of amyotrophic lateral sclerosis is unknown but Wechsler's (1940) studies on vitamin E therapy suggest that the question of nutritional deficiency cannot be ignored.

Then again there is a close analogy between the petechial hæmorrhages found by Patten and Alpers in the neighbourhood of the ventricles and those found in the periventricular grey matter in the Wernicke syndrome and the principal causative factor in the latter is almost certainly nutritional deficiency.

Several points of interest emerge from consideration of the peculiar disease in lambs known as "swayback". Innes and Shearer (1940) have shown that "swayback" occurs in the offspring of normal ewes and in most instances is present from birth. It appears to have its origin in a disturbance of copper metabolism which causes no obvious disturbance in the health of the ewe but exerts a pathological effect on the fetus or young lamb. Clinically there is generalized inco-ordination, marked spasticity and occasional blindness. The microscopic appearance of the affected brain is characterized by the constant presence of cortical nerve cell degeneration, severe demyelination and cavitation of the white matter with astrocytic glial proliferation. In a recent communication, Winkelmann and Moore (1942) have provided an almost perfect human analogy to "swayback". An infant with progressive spastic diplegia, convulsive seizures and marasmus died when twelve weeks old. Microscopic examination showed complete diffuse demyelination of the hemispheric white matter with symmetrical cavitation and an astrocytic gliosis. These authors express the opinion that their case may help to strengthen further the viewpoint of those who believe that antenatal factors may explain some of the clinical syndromes often attributed to birth trauma.

tracts existed at lower levels. In eighteen cases there was moderate loss and in ten complete absence of Betz cells. In three cases, although the giant pyramidal cells were apparently nearly or entirely absent, degeneration of nerve fibres did not become visible until they had reached the pons or the medulla or the spinal cord. These topographical differences were striking. Of the thirty spinal cords examined, fifteen appeared entirely normal, three showed moderate degeneration and twelve marked degeneration of the pyramidal tracts. Another point to be emphasized was the frequency with which there was concomitant involvement of other pathways, particularly in the lateral and posterior columns of the cord. Sclerosis strictly limited to the pyramidal tract occurred in but one instance.

In all cases in which pyramidal degeneration was present it was possible to demonstrate varying degrees of astrocytic gliosis. Such a finding ill accords with the conception of a primary arrest of myelinization in cerebral diplegia.

In the cerebral cortex various other changes were noted. Apart from the general poverty, irregular alignment and defective development of nerve cells, so often seen in the brain of the low-grade ament, one could often note small areas in which no nerve cells could be seen. In extent these varied from mere cell gaps only visible under high-power microscopic examination to larger and more easily seen areas of complete devastation. Sometimes oval and sometimes linear in outline, almost invariably they were limited to the third and fourth laminae.

Demyelination, either limited to the subcortex or widely spread throughout the white matter was another not infrequent finding. It appeared to be a characteristic feature in cases of familial diplegia and was invariably associated with a fibrillary gliosis readily demonstrable by the application of Holzer's stain.

Ganglion cell lesions of the basal ganglia are somewhat difficult to evaluate, requiring constant comparison with normal tissue, and further study is required but it may be said here that, in the striatum, loss of the large or of the small nerve cells or of both was a fairly frequent occurrence. An outfall was found in twenty-three cases—almost half the total.

Status marmoratus was found in one case. Changes in the pallidum were seldom noted.

*Cerebellar changes.*—When Collier addressed this Section he was able to refer to only one case of cerebral diplegia in which there were cerebellar changes. In the present series, they were extremely common. A completely normal cerebellum could be found in twelve instances only.

The microscopic appearances showed every gradation from localized loss of the Purkinje cells in one or two lamellae to complete and universal atrophy of the cortex of both the vermis and lateral lobes.

Gross atrophy all layers	...	...	...	...	...	...	8
Total or marked loss of Purkinje cells	...	...	...	...	...	...	7
Moderate loss	...	...	...	...	...	...	5
Slight loss	...	...	...	...	...	...	9
Proliferation of Bergmann's cells only	...	...	...	...	...	...	9
Normal	...	...	...	...	...	...	12

The elements most constantly involved were the Purkinje cells; their degree of involvement varied from an outfall limited to one folium to a complete disappearance in all areas and this cell loss showed no predilection for the neocerebellum.

The layer of Bergmann's glia cells was usually conspicuous wherever cell atrophy could be detected. In more advanced cases the molecular and granular layers shared in the atrophy.

The cause of this frequent implication of Purkinje cells is obscure but there is no doubt that these cells are exceptionally vulnerable, for Scherer (1931) mentions at least thirty pathological conditions in which these elements are affected. Degeneration secondary to involvement of the cerebral cortex is not a feasible explanation and it is obvious that birth injuries of a gross character can play no part.

Ellis (1918) stated that a deficiency of Purkinje cells is a characteristic finding in the cerebellum of the mentally subnormal and in large measure affords an explanation of the deficiency in motor co-ordination found in such individuals. This has not been my experience. Some years ago, W. Ross Ashby and I made a quantitative study of the Purkinje cells in the brains of sixty-two mental defectives. Counts below the normal density of 300 to 400 cells per sq. mm. were found in but five instances and, of this number, four were examples of infantile cerebral palsy. More serious consideration must be given to the claim of Spielmeyer (1930) that, in the epileptic, changes in the cerebellum are frequent and equal to those seen in Ammon's horn. He describes as characteristic proliferation of the fibroglia in the molecular zone, increase in the number of Bergmann's glia cells and, above all, loss of Purkinje cells. Of the sixty-two aments referred to,

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*History.*—Male infant, aged 13 months, bottle-fed, and weighing 26 lb., brought to hospital because of abdominal enlargement, said to have been present since birth, and to be increasing. Recently there had been fits of crying suggestive of abdominal pain, and for some days there had been vomiting after food.

*On examination.*—He was found to be a well-developed child, pale, listless, and fretful. The abdomen was grossly distended by an enormous tumour which filled the entire right side from costal margin to pelvis, and extended well over to the left of the mid-line (fig. 1).

*Investigations.*—Blood-count: Red cells 5,170,000; hæmoglobin 74%; white cells 7,500 (polymorphs 68%, lymphocytes 31%, monocytes 1%). A skiagram of the chest showed the cupolæ of the diaphragm raised to the 7th rib, but no other abnormality. Intravenous pyelography: Good filling of the left kidney; none of the right.

On these findings, a diagnosis of Wilms' tumour of the right kidney was made, and pre-operative X-ray therapy was given. Contrary to expectation, however, a total (skin) dose of 1,100 r units, at 200 kV., skin distance 50 cm., filtration (1.5 mm. Cu + 0.5 Al), given by two fields in a fortnight, did not cause any diminution in size of the tumour. Indeed, the mass appeared to be enlarging, and the child's condition was deteriorating. The pulse was persistently raised (120-130), and there was increasing anæmia. It was decided to operate without further delay.

*Premedication.*—Hyoscine, gr.  $\frac{1}{10}$ . Anæsthesia: Gas and oxygen, and wide local infiltration of the abdominal wall with procaine. Before commencing operation, an intravenous drip was started, and a catheter was introduced into the right ureter.

*Operation.*—A transverse incision was made. On exploring the abdomen, the kidneys were found to be normal; but arising from the inferior surface of the liver was a tumour, some eight inches in diameter. It was covered with peritoneum, and to some extent embedded in the under surface of the right lobe; it had no other attachments. There was no free fluid, and no other abnormality was found in the rest of the liver, or elsewhere.

After incision of the peritoneal covering of the tumour, a definite line of cleavage was found, and the tumour was separated from the liver with little bleeding. The raw surface of liver was drawn together with mattress sutures, and the abdomen closed.

The intravenous drip was maintained for twenty-four hours after operation, and by this means, as well as glucose and saline, 250 c.c. of blood was given. Massive collapse of the lower lobe of the right lung was diagnosed on the second day after operation, and necessitated an oxygen tent. Sulphapyridine was given, and recovery was eventually complete.

The patient was discharged on the thirty-third day after operation, and he remains well sixteen months later.

*Description of the tumour* (fig. 2).—The mass which weighed 4½ lb. was roughly spherical, some 8 in. in diameter, and dark red in colour. After removal, it became greyish-pink and shrank considerably in size. It was covered with peritoneum except for the area, about 3 in. across, which had been embedded in the liver. The surface

## CONCLUSIONS

Although much investigation has still to be undertaken, a number of facts stand out sufficiently clearly to justify certain generalizations.

First, there is no evidence in this series of fifty cases of cerebral diplegia of any morbid change in the nervous system which is invariable and specific.

Secondly, it may be observed that the lesions encountered in cerebral diplegia are of a character so diverse as to indicate that the hypothesis of a single cause common to all cases cannot be sustained.

Thirdly, the high proportion of cases born normally at term exhibiting marked degrees of microcephaly afford clear proof of the prenatal origin of the condition and suggest that birth injury has in the past been assigned far too large a part in the pathogenesis of cerebral diplegia, and, lastly, many of the lesions encountered in this investigation can best be explained on the basis of Collier's conception of a primary degeneration of the cerebral neurones. The aetiological factors concerned in this degeneration are likely to be numerous. The possibility that anoxæmia and nutritional deficiencies are among those concerned deserves serious consideration.

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The patient was discharged on the thirty-third day after operation, and he remains well sixteen months later.

*Description of the tumour* (fig. 2).—The mass which weighed  $4\frac{1}{2}$  lb. was roughly spherical, some 8 in. in diameter, and dark red in colour. After removal, it became greyish-pink and shrank considerably in size. It was covered with peritoneum except for the area, about 3 in. across, which had been embedded in the liver. The surface



FIG. 1.

Patient before operation. Note size of tumour.

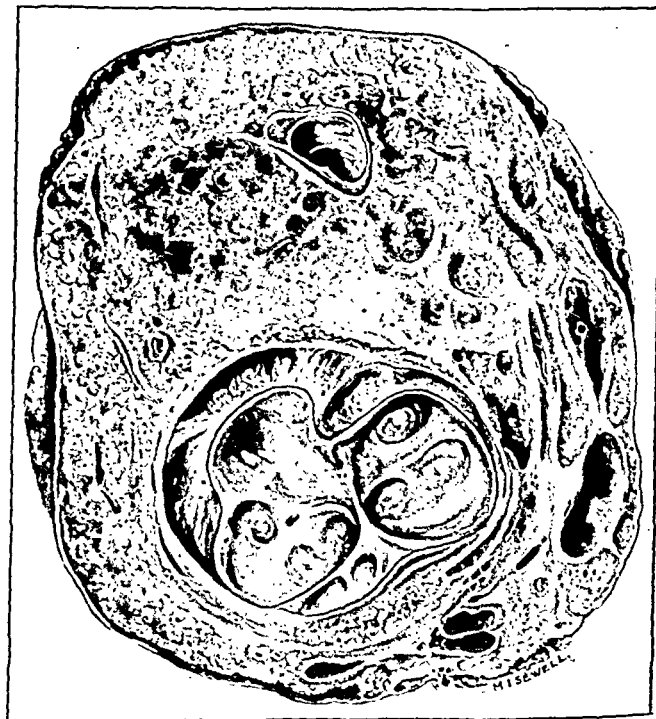


FIG. 2.

Appearance of tumour on cross-section (one quarter natural size).

FIG. 2.

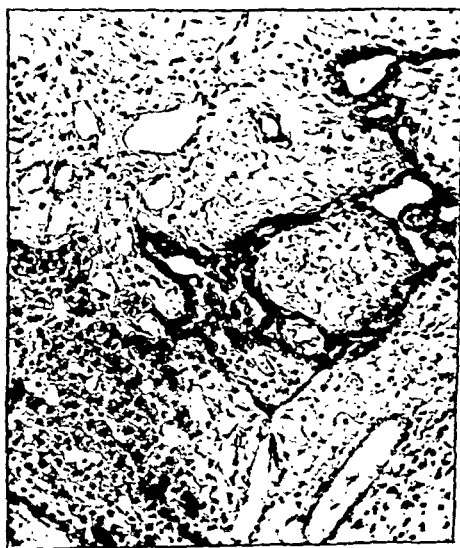


FIG. 3.

×120.



FIG. 4.

×400.

was somewhat bossed, and presented a number of cysts. The general feel and consistency were those of the uterine fibromyoma, and on section the tumour was tough and fibrous, the cut surfaces becoming convex after section. There were in the interior a number of cysts, including one about 3 in. across, with many loculi. The cysts were lined with a thin, white, glistening membrane, which can be seen in the picture to have detached itself by shrinkage from the surrounding tumour. The content was a watery fluid, which unfortunately was not examined for bile constituents.

*Histological examination* (figs. 3 and 4, Dr. Magnus Haines).—The general architecture of the tumour recalls that of a fibro-adenoma of the breast. There are the same masses of fibrous tissue and irregularly disposed groups of distorted "alveoli". In this tumour, however, the lining epithelium is of cuboidal cells, with large round central nuclei, and would appear to be of biliary origin.

Although macroscopically the tumour was encapsulated and sharply demarcated from the liver, traces of liver structure can be seen microscopically in all areas of the tumour examined. These have the appearance of having been surrounded and isolated by the growth of the fibrous tissue. The tumour does not appear malignant.

*Comment.*—The available literature does not give any example of an exactly comparable tumour. Bile-cell adenomata of the liver are of course well known, but they contain as a rule relatively little fibrous tissue; while many of the tumours described as fibromata have been multiple, and often there was a suspicion that they might have been manifestations of a cirrhotic process. Dr. H. W. C. Vines who examined the sections says that the mass may be a result of a hæmatoma in the liver, the tissue being regenerative and reparative rather than neoplastic. He points out the intimate intermingling of the fibrous tissue elements with the surviving strands of liver cells—an appearance certainly difficult to explain if the lesion is a benign neoplasm.

Against this view is the fact that the mass was still enlarging thirteen months after birth. There was no history of any natal or post-natal trauma. The general appearance of the tumour at operation, and its encapsulation and clean enucleation from its bed, were typical of a benign neoplasm.

*Discussion.*—Mr. DICKSON WRIGHT said that the only cells which could be clearly identified in the tumour were liver cells, so a hepatoma would possibly be the best description. The cystic spaces in the tumour probably contained white or colourless bile. The other swollen cells were probably altered by being choked with their secretions or storage products. He thought a section stained for glycogen might be interesting.

Dr. F. PARKES WEBER said that the absence of any vascular pedicle was remarkable in so large a non-malignant, encapsulated "tumour"; relative deficiency of blood supply would necessarily affect the histological structure. Besides strands of liver cells and of fibrous tissue there were masses of mononucleated-looking cells with very small nuclei and clear cytoplasm, which he thought were more probably derived from hepatic glandular cells than from connective tissue.

Whether they were glycogen-infiltrated cells—as Mr. Dickson Wright suggested—or not, he (Weber) would suggest that the "tumour" represented an attempt at the formation of another liver from a misplaced or separated embryonic rudiment—hindered by deficient blood supply.

#### Neurofibroma of Cervical Spinal Cord (Partial Removal).—G. H. MACNAAB, F.R.C.S.

*History.*—L. N., male, aged 18. Three years ago while cycling to work the patient ran into a motor car, went over the handle bars and struck the back of his head. Patient not unconscious, but was unable to move his upper or lower limbs. Six hours later was able to walk with assistance.

Patient able to return to work next day, but noticed tendency to drag right leg and tingling sensation on ulnar aspect of both forearms. He remained at work till January 1942, when there was gradual onset of weakness in his legs associated with pain across the shoulders, more marked in the right than left.

*On examination.*—Upper limbs showed wasting of the intrinsic muscles of both hands. On the right side there was weakness of the triceps and flexors of the wrist. The lower limbs showed severe spastic paraplegia equally marked in both limbs. Patient was unable to walk alone. There was marked sensory loss showing involvement up to the level of the 6th cervical segment.

*Operation* (13.6.42).—Laminectomy involving 4th, 5th, and 6th cervical vertebræ. Dumb-bell-shaped extradural tumour growing from the 6th right cervical root was exposed. Complete compression of the spinal cord was present. The intraspinal portion of the tumour was removed, and pulsation slowly returned in the spinal cord.

Normal sensation was rapidly regained and is complete. The upper limbs have regained full motor power except for slight weakness in the interossei of the right hand. The lower limbs show complete recovery. The patient has returned to work.



### Arteriovenous Aneurysm.—G. H. MACNAB, F.R.C.S.

*History.*—C. Y., male, aged 27. Five years ago the patient was involved in an accident and fractured his skull. An arteriovenous aneurysm developed between the left internal carotid artery and cavernous sinus giving rise to proptosis of the left eye with engorgement of the conjunctival veins; he complained of a noise in his head situated over the left temporal area.

The left common carotid artery was tied in India in 1938, but in spite of this operation the bruit continued and gradual loss of vision developed in the left eye leading to complete blindness. In January 1942 re-ligation of the left common carotid artery was carried out.

*On examination* (6.9.42).—Proptosis of the left eye with engorgement of the conjunctival vessels is present. The pupil is fixed and dilated. The fundus shows optic atrophy. The retinal arteries are largely reduced to white lines. A bruit can still be heard over the left temporal bone. X-rays: Show erosion of the apex of the left petrous-temporal bone.

*Operation* (1.10.42).—The left common carotid artery, and external and internal carotid arteries were exposed. The common carotid was found to be well ligated, but pulsation was present in external and internal carotid arteries. The superior thyroid and lingual branches of the external carotid artery were found to be larger than usual, suggesting reversed circulation had taken place. A ligature was applied to the external carotid artery proximal to the superior thyroid artery and pulsation ceased at once in the internal carotid artery.

*Result.*—Following the operation the bruit disappeared and the proptosis has subsided in a slight degree.

### Angioma of the Cerebral Cortex.—S. P. MEADOWS, M.D., F.R.C.P.

*History.*—Mrs. E. S. R., aged 44. Since age of 10, sensory focal epileptic attacks starting with deadness in left foot, spreading up left leg, left arm, and left side of face and mouth. Takes half an hour to spread, followed by pain in right side of head lasting up to two days, together with some weakness of left arm and leg. Sometimes has two or three of these attacks in a week. In February 1942 generalized epileptic attack, with loss of consciousness, burnt leg on fire, and is said to have foamed at mouth and bit lip. Quite well apart from attacks.

*On examination.*—Healthy-looking. No abnormal signs in central nervous system. Systolic bruit all over skull and right side of face and right eye. Bruit also well marked over right carotid vessels and base of heart. Obliteration of right common carotid artery causes diminution in bruit but does not obliterate it. Right carotid vessels hypertrophied and much more pulsatile than left. Right external jugular vein very prominent, and on coughing becomes sausage-like. Heart: Cardioscopy in February 1942 showed definite cardiac enlargement to right and left; blood-pressure 175/90. It is interesting that this patient does not hear a noise in her head, and apart from her attacks feels quite well.

### Calcified Intracranial Tumour.—S. P. MEADOWS, M.D., F.R.C.P.

*History.*—G. H., male, aged 70. From 1901 to 1924 he lived in South Africa. 1902: Attacks of severe headache and vomiting, which lasted some weeks; these attacks were attributed to sunstroke. He also had several falls about this time, but no further details are available. Soon after this he noticed loss of vision in the left eye, followed by impaired vision in the right eye. 1935: Cycle accident, ? fractured skull. X-ray of skull showed a cyst. For the past few years there had been a gradual intellectual deterioration, and his memory is now impaired. September 1942: Concussed and admitted to hospital.

*On examination.*—Elderly man, fair nutrition. Memory impaired, and confused at times.

*Central nervous system.*—Sense of smell absent left and diminished right nostril. Bilateral optic atrophy, more marked left eye. Visual acuity: R.  $\frac{6}{60}$ . L. blind. Visual fields: Right eye—temporal hemianopia up to mid-line and up to fixation point. Left

pupil fixed to direct light but reacts well consensually. Right pupil reacts normally. Hair distribution: Loss in axillæ and chest, diminished groins; but normal on face and abdomen.



Calcified intracranial tumour (1942) probably of 40 years' duration.

*Investigations.*—Casoni test negative. X-ray of skull: large calcified mass in mid-line above sella, extending into anterior and middle fossæ. Peripheral increase in density in wall of tumour. Sella not eroded. X-ray of chest normal. Cerebrospinal fluid: Pressure 40 mm. No cells. Protein 65 mg.%. Increased globulin. Blood Wassermann reaction negative.

The interest of this case lies in the radiographic appearances, and in the fact that this tumour has probably been growing for about forty years. The tumour is almost mid-line and suprasellar, and there is little damage to the sella itself. Any pathological diagnosis is probably guesswork, but possibilities appear to be meningioma, hydatid cyst, craniopharyngioma; cholesteatoma and even an aneurysm.

#### Extensive Angiomatous Formations on Left Fronto-parietal Cortex.—T. L. HILLIARD. M.R.C.S., L.R.C.P.

*History.*—E. D., female, aged 21. Perfectly well until the age of 9. Then, while out walking had sudden attack of paræsthesia with weakness and loss of use of right forearm. The attack lasted about twenty minutes. There were two recurrences at the age of 10, and at 11 the attacks became more frequent involving the right forearm and the right leg. At this time they were preceded by left hemicrania, followed by vomiting and lasted half an hour to the whole day, the more violent attacks lasting for the shorter period. She was treated as a case of hemiplegic migraine. At 12, the attacks were accompanied by aphasia. Sequence of events then was: Left hemicrania, weakness of right arm, then right leg, followed finally by vomiting.

In June 1939 (aged 18) she had her first fit which was preceded by focal symptoms on the right side and resulted in loss of consciousness for half an hour. Since then she has had similar attacks at ages of 19 and 20 with intervals of months of freedom. From October 1940 until September 28 of this year she has had no attacks of loss of consciousness.

In December 1941 arteriogram at Chase Farm Hospital revealed cerebral angioma.

Other features of the attacks: If the numbness and weakness of the right arm and leg lasted for more than three minutes she was unlikely to have a fit and become unconscious. She was perfectly well between the attacks, but since the beginning of second course of irradiation more persistent headache has been a feature. She has bitten her tongue but has never been incontinent. Since August 1941 attacks have been accompanied by right hemianopia. Luminal has made no difference to incidence of fits.

*On examination* (February 13, 1942, Dr. Meadows).—Systolic cephalic bruit of left eye. Bruit not abolished by pressing on both carotids. Both carotids beat forcibly. Cranial nerves normal except for slight weakness of lower right face on smiling. Slight weakness, spasticity and ataxia of right upper limb. Moderate weakness of right ankle.  $\frac{3}{4}$  in. wasting of right calf. Right knee and ankle clonus. Plantars flexor. All reflexes exaggerated on right side. Abdominal reflexes present. No cortical sensory loss.

At present she displays increased weakness of right upper and lower limbs and particularly of right foot, probably due to effect of irradiation œdema.

2.3.42-27.3.42.: First course consisted of irradiation with 4 g. bomb ( $3 \times 9$  cm. fields). Received to tumour 2,968 r, to skin 5,700 r. Now receiving further irradiation with deep X-rays.

#### Abdominal Actinomycosis.—G. WYNN-WILLIAMS, M.B., B.S., M.R.C.O.G.

*History*.—F. C., male, aged 26. Born and lived in London all his life. Admitted on 2.12.41 with a complaint of abdominal pain. Thirteen months previously he had had appendicectomy performed which was drained. He returned to full duty six weeks after the operation but his abdomen was never comfortable and always felt "loaded", and he still continued to get odd pains in his right iliac fossa. From then onwards until the date of admission, he was continually suffering from attacks of constipation and distension of his abdomen which were only relieved with large doses of purgatives.

*On examination* (2.12.41).—General condition good. Abdomen: There was a large mass in the right iliac fossa which was fixed to the abdominal parietes. The remainder of the abdomen was distended and visible peristalsis could be seen from time to time. He had not vomited on any occasion.

22.1.42: Laparotomy (Mr. Macnab). On opening the abdominal cavity, the right iliac fossa was seen to be filled with a mass of small intestines which were stuck together to such an extent that it was impossible to free them. The mass was intimately connected with the scar of the appendicectomy. An ileo-transverse colostomy was performed.

Progress was uneventful except that the area of the old appendicectomy scar became inflamed but soon settled down. The patient was discharged to Haileybury on 19.2.42 for convalescence.

12.3.42: Readmitted to hospital because he had developed a large fluctuating swelling over his 8th, 9th and 10th ribs in the axillary line. This abscess was opened, drained and explored. It was found to traverse the diaphragm to the abdominal cavity into the liver but did not appear to involve the pleural cavity. The abscess was drained and packed with sulphanilamide and very slowly began to close down. He then began to develop a swelling under his subcostal margin on the same side which became fluctuant and was opened on 2.5.42.

*Pathological report* on pus from abscess cavities revealed presence of *Actinomyces streptothrix*.

*Treatment* included large doses of potassium iodide up to 340 gr. daily over periods of two months, also actinomycotic vaccine (P. D. & Co.) in graduated dosage up to 1 c.c. twice weekly but irradiation therapy was not prescribed at any time.

*Present state* (25.10.42).—Sinuses now completely healed: has gained three stones in weight and has resumed work (lorry driver).

JOINT DISCUSSION No. 1

Section of Medicine with  
Section of Epidemiology and State Medicine

Chairman—GEOFFREY MARSHALL, O.B.E., M.D.  
(President of the Section of Medicine)

[October 27, 1942]

DISCUSSION ON THE CONTROL OF TUBERCULOSIS AS AN  
INFECTIOUS DISEASE

Dr. R. C. Wingfield: In order to have any hope of success, it is essential to realize that any policy to control tuberculous infection must be a long-term one.

I used to hold that the tubercle bacillus was ubiquitous (which it is) and that it was fairly evenly distributed over the country awaiting its victims, but that though the tubercle bacillus, the seed, was the obvious prime cause of tuberculosis, the soil on which it fell was by far the more important and determining factor in the cause of the disease. I am sure now that I was wrong; while the soil must be considered, the really important aetiological factor is *continuous prolonged exposure to infection*. This dogmatic statement I will support by two references.

(1) The work of the late Dr. Bardswell in his survey of tuberculosis in Cyprus, published by the National Association for the Prevention of Tuberculosis.

(2) The fact that the incidence of pulmonary tuberculosis is at least five times higher among close contacts to sputum-positive cases than among the general population.

The actual morbidity of pulmonary tuberculosis in Britain is unknown but is reckoned to be about 0.7% of the population, which gives a figure of about 350,000 cases. Of these a very large proportion are sputum-positive, and of these sputum-positive cases again a large proportion are subjectively well and are unaware of their condition. We have then an infectious army in our midst of probably somewhere about 250,000 persons. Death reduces their numbers every year by about 25,000. But their recruiting service is active and they refill their ranks yearly with new drafts. They train their recruits carefully and with great subtlety; they choose them young, implant the infection, but allow the recruit to be unaware of his enrolment, and to have a long period of good health in which to get well entrenched in the enemy's country by securing a position in the community, establishing himself among the body of workers, marrying, and taking on the full duties of citizenship. For some the probationary period is shorter than for others but sooner or later a very high percentage of those enrolled become fully trained, full sputum-positive, units of the infectious army. It is this infectious army that has got to be dealt with and destroyed. It is the continuous and automatically self-replenishing source of phthisis in our midst.

It is impossible by any method of treatment at our disposal at present to render its members sputum-negative in sufficient numbers to have any appreciable effect. We cannot remove sputum-positive persons from the population by segregation. Even if such a proceeding were possible, its logical effects are fantastic. It would mean, amongst other things, the closure of our ports to all visitors until they had submitted to an X-ray examination and had waited in quarantine for the result of the culture of their stomach washings on Lowenstein-Jensen medium. The control of tuberculosis cannot be approached as we do that of rabies and smallpox.

Our first task must be to search out and identify the unknown sputum-positive cases, the spear-head troops, who are the most dangerous. When discovered their lethal effect can be at once diminished. Here is a task for the general practitioner—he alone can do it, by constant watch of his patients.

The next task is to search for the newly enrolled recruits, and having found them so to handle them that they do not become full sputum-positive units of the infectious army. They can only be found by universal mass radiography. We can then prevent a very large number of them from becoming sputum-positive and we shall at least know at once when the others become dangerous. There will then be no more spear-head troops.

The infectious army will have its ranks thinned by a diminishing number of recruits as well as by the wastage of death, and when the number of recruits falls below the number lost yearly by death a start will indeed have been made, and the ranks should then dwindle by larger and larger percentages in each succeeding year. If this method does not result in the extermination of the infectious army, which seems hardly possible, it should reduce the numbers to proportions which can be handled, and which might even allow a segregation policy to be reconsidered.

Much can be done in the meantime to make the infectious army less dangerous and thus interfere with and check the enrolment of recruits. Naturally every effort will be made in each individual case to render him or her sputum-free or sputum-negative by the ordinary methods of treatment. The main method of attack should, however, be in strenuous efforts towards the improvement of public and private hygiene. It is probably due to our advance in this direction during the past forty years that the death-rate of tuberculosis has fallen so steadily and that the morbidity rate as shown by the Mantoux reaction is also apparently tending to fall. If that is correct it indicates clearly the best intermediate policy for the control of infection. A sputum-positive case is not usually or necessarily a great danger to the general public, but he is to those with whom he is in close and continuous contact. The ejected tubercle bacilli, if they do not fall directly on to, or into, their victims, have not a long life in a clean sunlit house or building. Every effort must be made to improve private hygiene by: Instruction to patients. Proper housing conditions for them with special attention to light and overcrowding. Slum clearance. Careful home-contact supervision. These are strong weapons, with the family doctor, the tuberculosis officer and the public health authority all working as a team.

The improvement of public hygiene should entail more attention to all the conditions under which people have to work. Factory acts have done much but more legislation is necessary and should be extended to cover *all* working premises. Every office and shop in the country should be made to conform to certain minimum standards as regards lighting, cleanliness, ventilation and overcrowding. To cite one example only, the bargain basements of many of our modern stores should make us feel ashamed. Keen action against public and private overcrowding and lack of daylight alone would give immediate results.

I have outlined a long-term policy and a short-term policy for the control of tuberculous infection vis-à-vis pulmonary tuberculosis. These policies are already in action but we must intensify that action and be continually trying to increase their efficiency. They will be successful. In conclusion here is a note of encouragement. In my routine weekly discharge of patients from Frimley about a month ago there were 5 patients. All of these 5 were, and had been, symptomless throughout, or else had had such slight symptoms that they had not noticed them. All were at the time of diagnosis on full work. All had frank pulmonary tuberculosis. They had been discovered by routine radiological examination either in the forces, or in their factories, or as contacts in their homes, and had thus been prevented from joining the infectious army.

**Dr. Cyril Banks:** The control of tuberculosis was first attempted on a national scale by the passing of the National Insurance Act 1911. The lines of attack were based on the report of the Departmental Committee on Tuberculosis (Astor Report).

The first unit of the scheme was the tuberculosis clinic, and its work included diagnosis, clearing-house functions, examination of contacts, after-care and education.

In thirty years nothing has happened to diminish the value of these measures as a programme for prevention. On the contrary, with modern X-ray developments (including mass radiography), with artificial pneumothorax and major surgery of the chest, and with *more* and better sanatoria, we are in a far better position than ever before to carry out the directions of the Astor Report.

There is one danger, and that is the possibility that tuberculosis officers may spend too much time on X-ray work and pneumothorax refills. This work has to be done, but if it takes the tuberculosis officer away from his social work and the following-up of contacts, it will be disastrous. We must have elastic ideas about the staffing of clinics and an increased number of doctors and radiographers so that the tuberculosis officer himself can concentrate on the main lines of social work and contact-following. A special type of man is needed as tuberculosis officer; he must be not only a clinician but also a social worker with an almost fanatical zeal.

**Wing Commander R. R. Trail:** *Problems connected with the patient who leaves sanatorium after treatment with positive sputum.*

(1) That such a patient is a potential focus of infection for his family, and far more commonly an actual focus for his fellow-workers, we all know. We will all agree that

he may be trained but cannot be compelled to take necessary precautions to safeguard such contacts. He will probably be extremely conscientious, in so far as his home circumstances permit, in carrying out these precautions in his contacts with his own family, but with the best of intentions he will be careless about them, or shy or actually afraid to carry them out in his contacts with his friends, and especially with his fellow-workers.

(2) During sanatorium residence all patients ought to be instructed on the elementary points of the dangers of uncontrolled cough and of the spray induced by talking. The tuberculous cough can be controlled much more than most doctors realize; it is most unusual to hear it during meals in a well-run sanatorium. Care should be taken to teach talking outside speech-spray distance; if this is not possible the patient should never talk directly at his listener. Further he should be trained on sputum and food-remnant disposal and on the proper washing of dishes and feeding utensils. A pamphlet on these essentials should be given to each patient before his discharge.

(3) Disposal of sputum is a great difficulty, however. The ideal is of course to empty it into an open fire, but this cannot be done at any time of the day by the ambulant and especially by the working patient, and makeshifts are either unpleasant or impossible. Some patients with only occasional phlegm may devise a method of carrying paper handkerchiefs which they keep after use in a special container, a strong paper bag or a small handbag, until they get home and can burn them. The sputum flask is a sanatorium or home-measure only; it takes a very brave man to produce it outside the sanatorium or his own home circle. Each flask should be filled to one-third at least with a concentrated solution of washing soda so that the sputum floats and does not adhere to the sides, thus making proper cleansing more difficult. Lysol solution should also be added. The contents may be poured into an open fire at any time; if they are to be emptied into a lavatory pan it is best to instruct the patient to keep the used flask firmly closed for twenty-four hours before disposing of its contents in this way. He should not use it again before he has treated it in the same way as his dishes and feeding utensils, i.e. by boiling in concentrated washing-soda solution. Cultures taken from articles so disinfected do not demonstrate tubercle bacilli.

(4) It is most important to stress the infectivity of food remnants; everything left after a meal should be burned immediately.

(5) The patient will in almost every case do his best according to his home facilities to protect his own family. It follows that the examination of home-contacts is not likely to disclose infections that have occurred after efficient training; these are likely to be, at whatever distance in time, the manifestations of infections prior to diagnosis. Papworth village settlement is standing proof of the possibility of complete control of home infection: no child born at Papworth has in twenty-one years shown any tuberculous illness in spite of the fact that in every case one parent has been colonized because of established phthisis. The great factor is, of course, that everyone is doing the same; continued medical advice and supervision make for the easy acquirement of a habit; the settlement is merely a continuation of that community sanatorium routine made so easy for the resident, but requiring after discharge not only individual effort but considerable bravery, as calling attention to a disability that means ostracism by one's fellows and possible loss of employment. Moreover we should remember that tuberculosis is a disease of adolescents and young adults, thousands of whom have no home life in the accepted sense. They live in one room, without any open fire, sharing communal bathroom and lavatory accommodation. Can we expect them to obey golden rules? They could not even if they would. They hide their disability; they are an uncontrollable source of infection. It is an inevitable conclusion that to examine the real contacts is to examine the whole population.

(6) If we cannot solve the problem can we do anything to prevent its present magnitude? Unfortunately we start off with a great handicap in that treatment is voluntary not compulsory. We could do much, however, to reduce this handicap. We could make no promise in every case to make the patient sputum-negative or sputum-free by longer residential treatment, but many more could attain this satisfactory condition if they were not compelled by economic reasons to leave against advice before reaching that quiescence which is the prime basis of a good end-result, and to work full time before that quiescence is consolidated to an arrest of the disease. The same bogey of want at home, of loss of employment and of permanently lowered standard of life, that forces one patient to delay his visit to his doctor and the giving-up of his work until he is an advanced case for hospitalization, rather than for treatment, militates in another, by continual worry, against the best results during residence, and after a time overcomes advice with disastrous results. Then he either returns to home and work with a positive sputum or soon re-accelerates his quiescent disease. In the average time of five years following his discharge he has at best but a 50% chance of being alive and during that time he has done untold damage to his fellows.

(7) The best method of dealing with our problem therefore, is to recognize its fundamental causes. We shall do nothing to better the present position until we subsidize the patient, first during treatment and later during rehabilitation, removing his fears for his family, and guiding him on the way to a return, with safety to himself and his fellows, to his own chosen work.

**Dr. J. B. McDougall:** It required nothing less than another Great War to bring about the revolutionary changes indicated by the Minister of Health in Parliament on October 8, 1942. More was accomplished in one day's sitting in the House of Commons than could have been dreamt of in ten years of peace.

In the epidemiology of tuberculosis, Bushnell, Cummins, and others have shown that in countries where tuberculosis is widespread the disease assumes a chronic and relatively benign type, but where, on the other hand, the disease is rare, the cases that do occur are as a rule rapidly fatal. Bradbury on Tyneside and Edwards in New York City, have investigated special districts with a view to determining the individual factors in infection and environment which may be responsible for the increased incidence of tuberculosis in groups of the population. It is not possible, however, to allocate to each factor its precise rôle in the spread of the disease. Edwards in New York has shown that the lowest incidence of pulmonary tuberculosis was found amongst college students and that the highest was amongst homeless unsettled males. At Saranac Lake, in some of the Welsh inquiries, at Preston Hall in Kent, and in Cyprus, a specially selected group of the population has formed the basis of investigations by different observers, and Bardswell has shown in Cyprus that in a land where poverty and other environmental factors are present, tuberculosis need not assume serious proportions so long as mass infection is controlled. At Saranac Lake and at Preston Hall, where presumably numerous opportunities for high-grade mass infection abound, the other environmental factors are such that there is a low rate of morbidity from tuberculosis and a complete absence of tuberculous meningitis in young children. Infection is probably the most important environmental factor. The prevention of tuberculosis is not to be solved by the entire elimination of the infective agent so much as by reducing its degree of infectivity. The challenge to the Public Health Service is to discover sources of infection. Every member of the population is potentially a contact to tuberculous infection and it is in the detection of large numbers of hidden cases that mass radiography will come into its own. It may soon verify the conclusion arrived at in 1921 at Framingham, where it was estimated that there are ten active cases for every death in the community and nineteen cases of all kinds for every death.

The demand on institutional accommodation in this country will have to be tackled with the same revolutionary line of thought that has brought the Minister recently to deal with problems of diagnosis. If we are to stem the tide of tuberculous mass infection we must utilize more freely the powers we now have to remove the case or alternatively to press for the raising of the standard of environment to such an extent that massive infection is curtailed to a minimum. The principles underlying the village settlement conception are ideal inasmuch as they embrace all the beneficial factors in the prevention of infection and improved environment.

It is to be hoped that the new scale of financial grants will be given only when treatment as recommended by the appropriate authority is carried out. Our first duty must be to segregate as many open cases as possible by the most humane methods at our disposal. Too many open cases remain less than six months in institutions in this country. The linking up of mass radiography and family allowances on the new and improved scale, together with greatly increased accommodation in well-equipped institutions, will do much to counteract the upward tendency of tuberculosis morbidity and death-rates.

**Dr. Trail (in reply):** This discussion has shown that there is general dissatisfaction over the control of tuberculosis as an infectious disease. All our methods, including intensive follow-up of contact cases, are not coping with the worry of incidence and the problems of breakdown following sanatorium treatment. The introduction of mass radiography gives us the opportunity of building round this procedure a central controlling authority under the Ministry of Health. Through it we could break down the county barriers of financial responsibility and establish on accepted lines criteria for the technical and clinical use of diagnostic and periodic-survey units for adolescents and young adults. Advances gathered from individual units could be disseminated to all, and through this method uniform lines of treatment and research would soon evolve, with general up-grading of tuberculosis work in every department.

## Section of Dermatology

President—H. C. SEMON, M.D.

[October 15, 1942]

Two Cases of Generalized Vaccinia (Vacciniola).—H. W. BARBER, M.B.

CASE I.—Male, aged 59. On May 18, 1942, Dr. Collyer of Croydon asked me to see a patient who had developed a widespread eruption closely resembling that of smallpox. On May 5 he had cut his chin while shaving and within three days the site of the cut had become inflamed, and it appeared that a boil or abscess was forming. Antiseptic applications, such as dettol, were employed. On May 12 there was itching of the trunk and limbs and a rash appeared. The arms were first involved, and later the trunk and legs, the lesions coming out in crops. There was little constitutional disturbance, and the temperature was normal.

On examination (May 18).—On the point of the chin was an ulcer of some depth with a granulomatous surface and covered in the centre by a dark, blood-stained crust. There was considerable induration, but no surrounding œdema, and the submental glands were not noticeably enlarged. The generalized eruption presented a striking picture. The face, neck, scalp, and upper chest were spared, but elsewhere it was profuse, particularly on the upper arms, the lower part of the back, and on the legs. The component lesions were infiltrated papules, deep-red in colour, and hard to the touch. The "shotty" feeling characteristic of smallpox papules was very evident. They varied in size from that of a split pea to that of a large pin-head. Many were surmounted by a vesicle, pustule, or crust—for the most part of small size, but on the left forearm was a bulla of recent appearance. The unbroken vesicles were very firm to the touch, like those of the smallpox exanthem. There was no apparent enlargement of the lymph-glands. The patient felt well, except that itching was severe. Temperature normal; appetite good.

I was forced to the conclusion that the initial lesion on the chin was a primary lesion of vaccinia, and that the eruption was the rarer of the two varieties of generalized vaccinia, namely vaccinal eruptive fever or *vacciniola*, the other variety, of course, being generalized vaccinia from auto-inoculation. The patient was exhaustively questioned as to how the cut on his chin could have been infected with the virus of vaccinia, but no definite clue was elicited, and it would be profitless to speculate.

I hoped to obtain from the initial lesion on the chin and possibly from the bullæ on the forearm proof that my diagnosis was right. Normal saline dressings were substituted for the antiseptics that had been applied to the chin, and Dr. Collyer reported that after these had been applied for twenty-four hours the lesion strikingly resembled a vaccinia pock. Swabs were taken from this and from the fluid in the bulla on the forearm, and these were forwarded to Sir John Ledingham, but the investigation was negative. It must be remembered, however, that Sir John did not receive the specimens until about the twelfth day after the infective lesion on the chin had developed, and the normal vaccinia pock begins to dry up by the eleventh day. Moreover the lesion had been dressed continuously with antiseptics for ten days before I saw the patient.

The lesion on the chin healed rapidly, and the secondary eruption had subsided completely within twenty days of its onset. Dr. Collyer recalled that he had vaccinated the patient some ten years previously, and that he had had an exceptionally severe reaction. In spite of the negative inoculation experiment, I have no doubt that this was a case of generalized vaccinia. The eruption in smallpox is unlike any other except that of generalized vaccinia, and of certain very rare cases of chicken-pox. In this connexion Bousquet declared that it is impossible to distinguish between the eruption of smallpox and that of generalized vaccinia. The apparent absence of pyrexia in my case would support Besnier's view that in the latter there is no fever unless some complication, such as adenitis, is present.

CASE II.—Female, aged 37. On August 18, 1942, Dr. Gordon Ackland asked me to see this Service patient who was stationed in a place where there was a smallpox scare. She had been vaccinated on July 30, and had previously been vaccinated in infancy.

This recent vaccination did not "take", but on August 15, i.e. sixteen days later and three days before I saw her, an eruption appeared, which, as in my first case, came out in crops, first on the arm near the site of vaccination, and then on the right hand, left chest, on both arms, and on one hip, leg, and foot. A single lesion was present on the left palm, and another on the nape of the neck. The lesions were exactly similar to those in my first case, consisting of hard shotty papules with overlying firm vesicles.

In this case one must assume that the vaccinal virus, although causing no inflammatory lesion at the site of inoculation, obtained entry to the blood-stream. The patient felt perfectly well, but complained of considerable itching. It will be noted that in her case



the interval between the vaccination and the generalized eruption was sixteen days, whereas in my first patient the incubation period was probably about four days. The usual interval is stated to be from four to ten days, but in Poole's case (Poole, T. D., 1893, *Vaccinal Eruptions*, Edinburgh, p. 108) it was thirteen to fourteen days, and in Dr. Colcott Fox's two cases (Fox, T. C., 1892, *Brit. J. Derm.*, 2, 287) nine days.

**Discussion.**—Dr. J. D. ROLLESTON: I agree with Dr. Barber's diagnosis. In my long experience of fevers I have seen only one case of generalized vaccinia (Rolleston, J. D., 1937, *Brit. J. Child. Dis.*, 34, 187) which is extraordinarily rare (Rolleston, J. D., and Ronaldson, G. W., 1940, "Acute Infectious Diseases", 3rd ed., London, p. 416). Unless there has been a pre-existing skin disease, generalized vaccinia seems to run a mild course, as it did in my case.

The PRESIDENT: It would be interesting to vaccinate the first case again. With the injection method of vaccination, is generalized vaccinia more common?

Dr. BARBER: Before Dr. Brain kindly supplied me with a vaccine made from the herpes virus, Prof. Eyre treated some of my cases of recurrent herpes simplex by subcutaneous injections of a diluted emulsion of vaccinia virus. Although a few patients had severe reactions—one developing encephalitic symptoms—no vaccinia eruption occurred.

**Nævus Flammeus Treated by Thorium X.**—H. C. SEMON, M.D. (President).

The patient, a healthy girl of 10, has been under treatment with thorium X in collodion varnish since January of this year. The *nævus*—of superficial type—without complicating fibrous or warty excrescences, involves the left side of the face, including the eyelids, upper and lower, and the left side of the nose, chin and upper lip. Originally of the so-called port-wine colour it is now much less conspicuous and less vivid in colour, owing mostly to the deposition of a brownish pigment, which largely masks the bright tinge of the underlying capillaries. There is no sign of atrophy. The doses of thorium X applied by myself on each occasion at approximately three weeks' interval, have been gradually increased from 1,000 to 3,000 E.S. units—eight in all. On every occasion except the first there has been a varying degree of inflammatory reaction, with some swelling of the eyelids for about twenty-four hours. I am showing the case with a view to eliciting discussion, and the experience which other members may have gathered in estimating the correct dosage, the appropriate time intervals of application, and their final results. The results at the Breslau and other continental clinics would seem to indicate that in selected cases thorium X is the treatment of choice, and in this instance I propose to continue the applications and show the final result towards the end of 1943.

**Discussion.**—Dr. ELIZABETH HUNT: At the Royal Sussex County Hospital a number of children with *nævi* have been treated with thorium X for over a year, at monthly intervals. A dosage of 1,000 units in alcohol has been used. No acute reaction has been observed in any case. The best results have been obtained in cases of *nævus flammeus*. Raised hemangiomas are rendered paler but are not noticeably reduced in thickness.

Dr. JACOBSON: If there is not a slight local reaction no effect is seen. Such reactions are without danger in the long run. I once treated a woman for *nævus flammeus*, for three years in increasing doses, up to 3,000 electrostatic units in 1.0 c.c. of varnish with marked improvement. However, she developed tiny warty growths in the *nævus* area, but these have not shown any malignancy up to now. 3,000 units should be the upper limit; for longer treatment it is advisable to go down to 2,000. If there is some irritation and inflammation, slight irradiation with ultra-violet light will lessen it and cause the effect to disappear within a short time.

A patient suffering from lichen planus annularis of the glans penis had two irradiations with marked inflammatory reaction. Ultra-violet light, not to an erythema dose, made the whole inflammation disappear. Thorium X in alcohol always produces a stronger reaction. It is necessary to find out the individual dose in every patient, and if the patient is fair and has a very sensitive skin, it is better to have an interval of four or five weeks.

Dr. PROSSER THOMAS: During the past six years about 60 cases of port-wine mark, both in children and adults, have been treated at St. Thomas' Hospital with thorium X, using 1,500 electrostatic units to the c.c. of alcohol (*St. Thom. Hosp. Rep.*, 1939, 4, 150). Almost all have improved, some markedly, and I have never seen any ill-effect such as atrophy or telangiectasia. Sometimes depigmentation develops in the lesion and seems to persist, but in other cases the tendency is to hyperpigment. I consider thorium X an excellent form of treatment for port-wine mark.

Three Cases by ROBERT KLABER, M.D.

(1) *Steatocystoma Multiplex* (Pringle).

This patient is a lad in the R.A.F. with unusually profuse lesions, for which I have used Pringle's original term "*steatocystoma multiplex*". The last case of this nature to be shown to the Section by Drs. Roxburgh and Muende was labelled "*Sebocystomatosis* (Günther)" (*Proc. R. Soc. Med.*, 1933, 26, 839). Though the terms are synonymous, Pringle's has priority, and Günther's no great advantage. In this case, no family history is available. Cysts are present in very large numbers, especially on the lower part of the chest, upper abdomen and on the back. They show the characteristic colour variations, varying from that of normal skin to a greenish-blue-grey. On puncture of some cysts, caseous, sebaceous material could be expressed; from others, a viscid but almost transparent oil was obtained. I have seen several other less severe cases amongst troops. I have not attempted any treatment. Stokes recently described the successful result of evacuating all the cysts, with no recurrence.

**Discussion.**—Lieutenant-Colonel R. M. B. MacKENNA: Should a man in the condition shown in this case, who complained of considerable irritation, be allowed to go abroad?

The PRESIDENT: The case is one which, as the back is affected, should be marked militarily in category C. No such patient can be expected to carry a pack.

Dr. ISAAC MUENDE: Pringle described his cases of *steatocystoma multiplex* in men between the ages of 20 and 30, and it was Günther who described the pathological process and suggested the name of *sebocystomatosis*.

Dr. A. C. ROXBURGH: The only other case I can remember seeing was in a woman of 34 who had had the cysts since the age of 15. The lesions were mainly on the lower sternum but were all over the trunk, none were on the face. The largest were about 1 in. in diameter. They contained oily fluid which escaped on puncture and was followed by a yellow semi-solid on squeezing the cyst.

Dr. ELIZABETH HUNT: I showed a case at a meeting of the Section (*Proc. R. Soc. Med.*, 1936, 29, 720). This was a woman aged 27 whose lesions were on the trunk. I have seen another woman in the twenties with this condition (*Brit. J. Derm.*, 1936, 48, 386).

## (2) Dermatitis Artefacta.

A young married woman showed, confined to her left arm, a patterned, crusted, discoid eruption, the appearance of which leaves no doubt as to the diagnosis. She denies any knowledge of having herself produced the lesions.

I would be interested to know how other members of the Section treat such cases.

Dr. F. PARKES WEBER: Many years ago I showed at the Section the case of a woman who had an obvious dermatitis artefacta on the front of the abdomen (*Proc. R. Soc. Med.*, Sect. Derm., 1911, 4, 43 and 1912, 5, 87). I had seen a good deal of her previously. In 1896 and 1897 she had vomited scybalous fragments and enemas containing oil or methylene-blue (F. P. Weber, *Brain*, 1904, 27, 170). She had had four exploratory laparotomies, the last one by Sir Frederick Treves (*Trans. med. Soc. Lond.*, 1898, 21, 224) who found nothing abnormal, excepting adhesions left by previous operations. In 1912 I published a complete account of her case in the *International Clinics*, 22nd series, vol. i, pp. 125-138. Such patients are obviously much to be pitied, though they can live a useful life between their periods of peculiar mental disturbance.

## (3) Erythema Gyrate Perstans (Colcott Fox).

Girl, aged 22, in whom the eruption first appeared when she was only a week old, while her mother was suffering from puerperal fever. The lesions have continued ever since. They occasionally get worse and then better, but she has rarely been free of them for more than a few days. The only occasion when she was completely free for any length of time was after an exacerbation following tonsillectomy. We owe the original description of this condition to Colcott Fox who described it as "erythema gyrate perstans" (*Internat. Atlas Rare Skin Diseases*, 1891, xvi).

She shows on the trunk and thighs an extremely bizarre, figurate eruption. This consists of areas of very slight central pigmentation with a desquamating margin, bordered by a flat or slightly raised arcuate erythema. A few areas show flaccid vesiculation as a precursor of the desquamation. When I saw the patient for the first time yesterday, her tongue showed three small shallow "geographical" lacunæ which seem to have disappeared entirely to-day. When, however, I asked her to put out her tongue to its furthest limit, two such small areas were observed on the lateral surface. Is there any possible link between these relatively common gyrate migrating lesions on the tongue and this rare eruption?

*Discussion.*—Dr. ISAAC MUENDE said that Lipschutz's erythema chronicum migrans was always associated with one or two large lesions on the limbs only, whereas Darier's erythema annulare centrifugum occurred on the trunk only and the lesions were small and numerous.

Dr. H. W. BARBER: I think Darier's term—erythema annulare centrifugum—is the best for this condition. In most cases, at any rate, the eruption appears to be a manifestation of chronic infection with, and sensitization to, a streptococcus. The most remarkable case I have seen was a man on leave from the East in whom the usual circinate lesions were present on the trunk and limbs, but on the occipital region of the scalp were large indurated plaques, so massive as to be visible from a distance. The eruption responded rapidly to sulphanilamide but relapsed when this was discontinued. He was found to have a chronic sinus infection with an empyema of one antrum. He was successfully operated upon by Mr. Zamora and after a further course of sulphanilamide the eruption cleared up completely and he had no relapse. One significant point in Dr. Klaber's case is that the lesions first appeared when the patient was only one week old, and that the mother had puerperal septicæmia.

## Schaumann's Disease.—H. W. ALLEN, D.M.

Mrs. W. T., aged 45, a vegetarian, married two years. No children. Two brothers tuberculous, one having died.

There is a five years' history of appearance of congested nodules in the dermis, showing brown on diascopy, on the face, extensor aspect of upper arm, and anterior aspect of left thigh. There is a lesion occurring as a plaque on the right upper eyelid, and telangiectasia accompanies the lesions. The temperature is slightly raised as in another case which I observed.

There is marked adenopathy, and the right epitrochlear gland is unusually enlarged. Contrasting with this, the spleen is not at all enlarged by the usual criteria. Lungs: Referable to a severe attack of influenza and rheumatism three years ago, the skiagram of the chest shows increased hilar markings on the right side, where harsh breath sounds are heard.

Bones: One of the left metacarpals and one of the subterminal phalanges show an early stage of sarcoïdal osteitis, or cystic tuberculous osteitis.

Blood: Anæmia; hb. 75%; leucocytes 7,800: Differential monocytes 8%.

13.10.42: Mantoux reaction, Koch's Old Tuberculin, 1:1,000, positive.

The histology of the lesion shows a typical sarcoïd of Boeck infiltration with epithelioid cells, surrounded by a few lymphocytes, and containing an occasional giant cell. There is slight necrosis within the collections of epithelioid cells.

*Treatment.*—She has been treated previously with injections of bismostab without improvement, and has, since coming under my care, been treated with sanocrysin, or rather novacrysin. It is too early to say whether improvement has occurred. An interesting feature of this case is the family history of tuberculous infection occurring in two brothers, one of whom died. The delayed positive Mantoux reaction is supposed to indicate the transition to active tuberculosis occasionally seen in these cases. I am treating her with gold injections, and hope to show later that this transition can be averted. (Dr. Allen, on the request of Dr. Parkes Weber, demonstrated the skiagrams of the patient's hands and indicated the appearances.)

*Discussion.*—Dr. PARKES WEBER: The minute, round cyst-like spots in the skiagrams of the phalanges are typical for sarcoidosis.

Dr. H. S. STANNUS: It would be interesting to hear what proportion of cases exhibiting sarcoids of the skin develop visceral lesions? I have a woman in hospital with sarcoidosis of the lung; she had two subcutaneous tumours, one of which was removed about fifteen years ago.

Dr. ELIZABETH HUNT said that recently a number of cases of sarcoidosis of the lungs with skin lesions had been reported (*American Journal of Roentgenology*, 1941, 45, 505).

? **Telangiectatic Lupus Erythematosus.**—GEOFFREY DUCKWORTH, M.R.C.P.

Mrs. M. M., housewife, aged 34 years. For the past seven years the skin on the backs of the fingers has been swollen, atrophic, and telangiectatic. The swellings, which are spindle-shaped, feel spongy. On the scalp there are two small oval atrophic areas, about one centimetre in the long diameter, which are depressed, erythematous, and form scales. The patient states that there have been small, oval scars on the calves of the legs.

Before coming under observation she had had about six exposures of ultra-violet rays to the backs of the fingers, but does not remember any redness following. The skin had its present appearance before the treatment. The general health is good; the W.R. is negative, and the Mantoux also. She has been taking nicotinic acid, 50 mg., t.d.s., and has had a course of bismuth injections. She thinks there is a slight, but definite lessening of the condition.

**Persistent Intertrigo.** ? **Diagnosis.**—ALICE CARLETON, M.B.

J. P., a female child, aged 5 months.

*Clinical history.*—Normal birth in May 1942. The mother had pulmonary tuberculosis, and was in a sanatorium for three months during the pregnancy. She is now apparently well. The father and elder child, aged 3, are both healthy.

Birth-weight 6¼ lb. Breast fed. At the age of one week the child developed a discharge from both eyes, for which she was treated at the Oxford Eye Hospital. This was followed at the age of 5 weeks by an otitis externa, first in the left ear, and three days later in the right. Very soon afterwards, the natal cleft and vulva became affected, followed by the anterior right axillary fold, and at 19 weeks, the groove between the lower lip and chin.

*Present condition.*—The affected areas show a background of bright erythema associated in some places with slight œdema. In the centre of the patch, thick, sodden, white, desquamating epidermis is seen, looking like whitewash roughly applied. Behind the ears, outside the sodden area, the skin is thin and glazed, and the follicles show as whitish pin-points. In the genital region, the insides of the labia majora, and both sides of the labia minora are covered with sodden epithelium and the perianal region is similarly affected. If not constantly cleansed, the areas become very foul smelling. The small patch on the chin, which is of recent development, is brownish rather than white.

*Investigations.*— $\beta$  hæmolytic streptococci, *Staphylococcus aureus*, *B. coli* and *Pseudomonas aeruginosa* have been cultivated on different occasions, but no one organism has been constantly found. Wassermann reaction negative. Tuberculin patch test negative on two occasions. Fæces: No parasites, ova or cysts found. Blood-count: No significant abnormality.

Biopsy from skin of buttock: Dr. Robb-Smith reported "sections show hyperkeratosis with an excessive quantity of keratin in the mouths of the hair follicles. There is a moderate degree of hypertrophy of the epidermis, with some thickening of the rete pegs. In one or two places, there is a slight amount of acute inflammatory infiltration of the epidermis and that part of the dermis immediately underlying. Elsewhere, there is a very slight, chronic inflammatory, chiefly perivascular infiltration of the superficial layers of the dermis. In one place, small œdematous bullæ may be seen. There are no specific features in the lesion and it resembles an intertrigo with hyperkeratosis and follicular keratosis." Dr. Freudenthal who saw a slide said it was like the picture in the quiescent stage of a chronic œdema.

*Treatment.*—The following lines of treatment have been tried without success and have been accompanied by a slow spread especially to areas of skin contact: Crystal violet and brilliant green, 0.75%. Penicillin, locally. 5% sulphanilamide ointment. X-rays, 150 r with a 1 mm. aluminium filter on two occasions. Sulphapyridine *per os*. Haliverol, *per os* and also cod-liver oil locally. The general condition is good, and the child is gaining weight, though at first she failed to do so. She has been bottle fed since the age of 16 weeks, and now weighs 9½ lb.

*Discussion.*—The PRESIDENT: Can diphtheria of the skin continue for as long as this?

Dr. J. D. ROLLESTON: It might do so. Diphtheria like syphilis is a good imitator and its lesions may remain unrecognized for a long time.

Dr. H. S. STANNUS: A deep diphtheritic infection of the skin is seen in tropical countries accompanied by ulceration. In this case the distribution of lesions about the vulva, the perianal region, and around the eyes, is very like that due to riboflavin deficiency.

In the present case it might be worth while giving riboflavin on the supposition that there was an infective condition superimposed on an arboflavinosis.

**POSTSCRIPT.**—Monilia and the Klebs-Loeffler bacillus were repeatedly looked for, without result.

## Section of Orthopædics

President—B. H. BURNS, F.R.C.S.

[October 20, 1942]

### DISCUSSION ON PAINFUL FEET

**Mr. C. Lambrinudi :** The foot problem in the Army is a fairly formidable one. In my experience alone, working at several clinics, I find that a third of the cases sent up by the regimental officers for an expert orthopædic opinion are foot cases.

Most orthopædic surgeons in charge of busy clinics, if asked before the War who suffered most from foot trouble, men or women, would unhesitatingly have answered—women, in at least a proportion of 5 to 1. Because so many of us had become accustomed to associate foot pains and deformities with women, the erroneous conclusion was drawn that they were due to some female peculiarity or to their particular form of footwear. But experience of war has shown that foot troubles are as common in men, under stress, as in women. This was not realized in peace-time because men did not then use their feet to the same extent, or under the same trying conditions. A man was better able to select his occupation according to his capacity. He could rest at weekends, and, on the whole, did not go to a doctor unless his disability interfered with his wage-earning capacity. But a woman was constantly on her feet tending her home and children; she did not rest at weekends, and she was periodically subjected to the stresses of pregnancy. Moreover, women were employed in larger numbers in such trying occupations as shop assistants and waitresses, and because of restricted choice they were obliged to wear shoes unsuitable for overworked feet.

It is evident that the foot problem on the whole is muscular fatigue, leading to ligamentous strain, and foot-wear only came into the picture in so far as it was an extra stress. Though there were exceptions, it was the fatigue that produced most of the deformities and not the shoes. Preconceived ideas, however, are difficult to get rid of, and some of us still fail to see that the problem of the soldier's foot to-day is identical with that of the woman's foot before the War, but often in an earlier stage. There is, I fear, a deplorable tendency to regard soldiers with suspicion, to accuse them of exaggerating their symptoms, and I have even heard some responsible medical men say that the majority of soldiers were neurotic. If by this it is meant that their disabilities get on their nerves, I agree, but we should not allow suspicion of "swinging it" to intrude itself and influence our clinical judgment.

Most of us must have been impressed, both in our hospital and private practices, by the fuss made over what seems to us a small thing, and the amount of gratitude we receive for doing a trivial job. In broad terms we can say that the moral effect of a disability is inversely proportional to its severity. When a patient has pain associated with a gross ailment, he restricts his activities according to his capacity, but when he has pain associated with a minor condition, he continues to compete with normal people at a disadvantage, and sooner or later his morale breaks down. What gets on his nerves is his inability to keep step with others, as is borne out by an analysis of complaints that soldiers make—"I can't keep up with the others", "I can walk 4 miles at my own pace but can't march a mile", "I get ticked off for shuffling my feet on parade", &c.

In protesting against too lavish a use of the expression "psychological causes", I do not forget there are other causes of foot strain besides fatigue. There is, for instance, the asthenic atonic individual whose muscular tone is so poor that he cannot hold his

feet in the correct position for any length of time. He ought never to be in the Army. There are, too, the associations of emotions and posture, such as the depressed individual whose feet are as flat and sad as his face. There is no place in an orthopaedic centre for the uneducable and morose, but one must not confuse the true psychoneurotic and the unwilling soldier with the far larger group of men with a legitimate grievance who have been forced to exaggerate their symptoms in order to have some notice taken of them.

I am often asked why the feet do not, as it were, hypertrophy like other organs in response to increased activity. The answer is that they do respond, if treated with imagination and determination, but imagination seems lacking if the Army marches on its corns while, as I am informed, there are many chiropodists serving in the Forces not engaged in their own invaluable work.

But, apart from a plethora of corns, in the category of A I men one finds an odd assortment of feet. As the foot has not yet completely adapted itself to the erect posture, it is more prone to minor congenital variations than any other part of the body. Consequently minor degrees of hallux valgus, pes planus and cavus, metatarsus elevatus, supinated fore-foot, &c., are commonly found in men in this category. In the ordinary course of events these do not give rise to any symptoms on account of the excellent adaptability of the muscles which mask any disability which might be due to them. In fact it can be said that the physiological adaptation of the body to the erect posture is far in advance of the structural. But, if anything interferes with the tone of the muscles, of which the commonest cause in soldiers is local or general fatigue, the weakness inherent in these mild abnormalities becomes apparent. That such feet can gradually be worked up to an amazing state of efficiency is demonstrated in the case of regular soldiers of about 30 or more, who have been in the Army for a long time, and it is not uncommon to see men with marked hallux valgus and pes planus whose feet are supple, painless and powerful, and who, despite their deformity, can walk in complete comfort 20 miles or more. Stress of circumstances denies this opportunity of gradual training to our present soldiers, and many of them break down through being forced too quickly. And this applies as much to normal as to abnormal feet.

The foot has two functions, *balance* and *propulsion*, and it is convenient to discuss the foot problem under these headings. I want to make it clear, however, that I am considering the causes of breakdown of potentially A I feet only.

#### BALANCE

Too little attention is paid to balance in training recruits, and I regard the balancing test as the best index of a borderline foot's potentialities. Its value lies in the fact that good balance implies good tone, and if the tone of the muscles is good, and the foot supple and painless, there is a good chance of survival of function despite minor structural abnormalities. When a joint is in the resting position all the muscles around keep it steady. The normal resting position is so placed that the muscles act through their inner range. Any deviation from the normal tends to make the muscles on the convex side act more and more through their outer range, which is the weaker. Nevertheless, within the fairly wide limits of normal, stability is maintained without the foot coming to any harm, because the tone of those muscles becomes adapted. This is exemplified in the hysterical and hemiplegic foot where the patient rarely complains of ligamentous strain pains because the muscles take the weight and not the ligaments. But even more convincing are the frequent cases one sees where a man has walked valgus for years unaware of a painful focus on the outer side of the foot. He has got accustomed not to tread on it and has therefore forgotten it. His tonic reflexes have become attuned to this position and he has suffered no inconvenience from his abnormal method of walking.

*Valgus foot* : It is commonly assumed that the muscles on the inner side of an habitual valgus foot are weak, a fallacy based on regarding muscle as having the properties of elastic, and not as specialized live tissue of which tone is one of its outstanding characteristics. Since, however, the muscle on the inner side acts through its outer range, the margin of safety of the ligaments on that side is reduced. Consequently, if the tone of the muscle is not tuned to the proper pitch, any sudden or prolonged force will fall upon the ligaments instead of being taken by the muscle. Unfortunately, when such a case breaks down during a severe test he is too often diagnosed as "flat foot" and ordered inside wedges.

The belief in wedges as a curative agent is based on the assumption that the ligamentous strain is due to fatigue of the muscle, which is too weak to take the load, and that by reducing the load by means of wedges or supports, fatigue will be prevented and the

muscle thereby strengthened. The reverse is the case. The failure is not due to defective muscle power but to inadequate tone due to insufficient training. If wedges are given, and act effectively, the only stimulus which would improve tone is removed, and the man will never again revert to his own normal. I cannot condemn too much the indiscriminate use of inside wedges for such border-line cases. Fatigue and strain are inevitable for both normal and abnormal feet during the process of intensive training. No permanent damage will be done if these early strains are treated early and rationally, but supports and training are incompatible terms. The right treatment is to rest the foot and give it physiotherapy until all pain disappears, and then concentrate on restoring and improving tone by means of balancing exercises. Make the man stand on his foot until he has learnt to become steady, then gradually add to the load by making him stand on outside wedges. By degrees work him up to a high standard of balance tolerance. This at least is physiological, for instead of removing, it provides and gradually reinforces the stimulus to which his tonic reflexes had previously been attuned.

Elevation of the little toe is an example of the structural abnormality of the balancing mechanism of the foot. If perfect compensation has occurred so that balance is good, and all the other toes are firm on the ground it is justifiable to amputate the little toe for pressure pain and expect the man to remain in Grade 1, but these cases are rare. More commonly it is found that the balance is extremely poor, and the fourth toe also tends to rise; if the little toe is removed the fourth toe will rise still more and the balance will be made worse. In carefully selected cases it is worth while doing a plastic operation on the little toe and tenotomy of the fourth toe. I have had some very satisfactory results but do not recommend it as a routine procedure. It takes a long time, for the toes must be kept in plaster for five to six weeks to prevent contraction and then the man will have to be retrained.

The part the big toe plays in balance is extremely well demonstrated in a marked case of metatarsus elevatus and hallux valgus. In the former the head of the first metatarsal bone is well above the level of the others, and the big toe is so engaged in balancing that it cannot dorsiflex while walking, even though there is no mechanical obstacle to dorsiflexion.

Minor degrees of this deformity are compatible with an efficient foot, if the balance is good. If not, the toe will be unable to stand up to heavy work and hallux rigidus will certainly appear.

*Hallux valgus*: I usually find that soldiers sent to me with the diagnosis of "flat feet" and "hallux valgus" have had their pain for a long time. Some may have had their boots stretched or a lighter pair ordered, with only temporary relief. Others have been excused route marches and P.T. but have been given light duties which entail guard and working in the cookhouse wearing plimsolls. By the time they come up for a second opinion they are disgruntled men, and on questioning them carefully one finds that many complain of pain in the sole of the foot as well as in the big toe. Sometimes the pain in the sole preceded that in the toe, and all the men complain that for a long time their feet have ached when standing. It is evident that the R.M.O. did not recognize the fatigue element and mistook the pain in the toe as being due to pressure—an extremely common fallacy.

There are only three reasons why a man's boots which have previously been comfortable suddenly become tight: (1) The boot may have shrunk; (2) the foot may have hypertrophied; or (3) the foot may have altered its shape. In the majority of cases it is this last which has happened. The evidence that early pains in a big toe are due to strain and not pressure are these: (a) The soldier may have been comfortable for a long time before the pain appeared, and may even have been able to break in his boot to produce a bulge for his bunion. (b) There is no redness over the prominence. (c) The maximum point of tenderness in early cases is below or in front of the prominence. (d) The abductor muscle of the big toe often stands out in spasm, and the man may complain of cramp in it both during the day and night. (e) There may be an ache in the sole of the foot as well as the big toe. (f) The same symptoms are noticed in walking and standing about in plimsolls. (g) The foot may have flattened and a hallux valgus increased lately.

I cannot emphasize too strongly that pain in the big toe, with or without a pre-existing hallux valgus, is often one of the signs that the whole foot is fatigued and wants rest.

There are two other deformities likely to find their way into the A 1 grade because during civil life they did not give rise to much trouble—the supinated fore-foot and the slight cavus with a marked cavus on the outer side. Such cases should be regraded at once. The supinated foot cannot adapt itself to hard work, and when it breaks down it commonly gives rise to spasmodic valgus. It can, however, be made comfortable enough with an arch support for the man to carry on in a lower grade.

The external cavus foot looks a good foot. It is supple and the calf muscles are usually

powerful, but it is a narrow foot and has a tight plantar fascia. It is excellent for running, not quite so good for walking, but hopeless for standing, because it tends to buckle like scoliosis.

I have stressed this balancing function of the foot because sufficient emphasis has not been laid on it in textbooks and it makes intelligible certain apparent inconsistencies: (1) It is not inconsistent for a man to be able to run about and enjoy football, yet complain of fatigue when standing on guard. (2) Standing must never be regarded as even partial rest for a fatigued and strained foot. (3) Pain in a previously painless bunion is usually a sign that the whole foot is tired and wants rest.

#### PROPULSION

Since in this paper I am concerned only with fatigue and strain I will confine myself to the plantar fascia and the muscle which arises from it. The plantar fascia is a passive structure and so placed that it acts as a bow string to an arch. It is attached to the heel behind, and in front each of its five digitations are attached to the flexor sheath and on either side to the transverse metatarsal ligaments. The flexor brevis digitorum arises from its upper surface, and when it contracts it tightens the posterior part of the fascia and relaxes the anterior. In fact, that muscle's main function is to protect the fascia from being overstretched. I believe that when the plantar fascia is stretched, a stretch reflex is produced which make the flexor brevis contract and sets in motion a flexor response of the toes.

The short muscles of the foot attached to heel and toes have to withstand the distraction pull of the tendo achillis and the weight of the body. None of them can stand up to it alone, but all working together with the help of the long flexors of the toes can do so. If any of them fails for long the mechanism of the foot is badly affected.

I believe that the fleshy origin of the flexor brevis is liable to strain and fatigue, especially in young recruits who have not used their feet much, and in consequence it is liable to become tender, subject to cramps, and a fertile soil for the fibrositic nodule. Furthermore, when its action is so weakened, strain falls on the front part of the plantar fascia, giving rise to symptoms simulating metatarsalgia.

*Pain in the flexor brevis muscle.*—Cases are often sent up labelled "flat feet". The pain complained of usually started some time previously during P.T. or a cross-country run, or after a prolonged route march. Pain occurs in the sole of the foot, extending into the toes and up the inner side of the ankle after walking a few yards. When walking the men hold their toes cocked straight up in the air, or in the claw-toe position, as if by voluntary effort. They walk with a shuffle and are careful not to use their toes, and they cannot stand on tiptoe on account of pain in the sole of the foot. On examination, the foot is usually supple, there is no tenderness in the metatarsal heads, the big toe is freely movable and strong, the other toes are painless on passive movements but flexion against resistance is weak and causes acute pain in the sole of the foot, which is also tender. When each toe is made to flex against resistance separately, only one or two, usually the second and third, are painful, and a search along the line of the affected toe reveals an exquisitely painful spot. Pressure on this reproduces the pain complained of, injection of local anaesthetic entirely abolishes it, the toes come down on the ground and the gait is normal. The similarity to tennis elbow is striking, as is also its tendency to chronicity. There is the same wide reference of pain, the same muscle tenderness, subjective and objective weakness, the acutely tender spot and the response to local anaesthesia. Moreover, like a tennis elbow, it is those cases which come on the day after strenuous exertion rather than as an acute injury which are the more difficult to treat.

*Strain in the anterior attachment of the plantar fascia.*—The association of strain of the plantar fascia and metatarsalgia is not recognized, but I believe it to be a definite clinical entity. Men sent up with a diagnosis of metatarsalgia frequently say that during a particularly strenuous route march they suddenly got an acute pain in the fore-part of their foot. On questioning one finds that for a long time they have had pain in the sole of their foot and fatigue in marching. They get tired on guard, shuffle their feet on parade and are often distressed. There is no marked deformity of the toes, the maximum tenderness is not over the most prominent part of the metatarsal heads, but a little in front of them or on either side acutely tender areas can be found. There is pain on passive dorsiflexion of the toes but none on passive flexion or flexion against resistance. The second, third and fourth toes are usually involved but never the big toe; metatarsal bars or pads do not relieve but make the pain worse, as would be expected. Relief is obtained by flexing the toes on the ground, the opposite of that which

obtains when the lesion is situated in the flexor brevis muscle itself. These cases have almost always been given metatarsal bars, on the assumption that the pain is due to pressure on the metatarsal heads, like the familiar type of metatarsalgia. They are another example of pain from strain being confused with pain from pressure.

These lesions of the plantar fascia may have serious consequences. Not only may they give rise to deformity, at first voluntarily produced to relieve pain and later fixed by contractures, but even when there is no deformity, loss of function of the toes and progressive deterioration of the foot will follow.

#### ORIGIN OF DEFORMITIES AND TREATMENT

The main reason why the foot problem has become shrouded in pessimism is because most of the deformities we saw before the War were established—they had got past the stage where one could distinguish between cause and effect. Our treatment of necessity was mechanical, by supports, or some form of violence, operative or otherwise. But I have seen almost every variety of toe deformity we were accustomed to see in pre-war days in women, appear in soldiers in an acute form and have watched them revert to their normal under the soothing influence of rest and physiotherapy. I have not the slightest doubt that the foot problem in the Army is due to fatigue and hasty training, and the failure to recognize in time the signs of impending breakdown.

Hospital treatment even for minor cases saves time in the long run but there is a widespread feeling that the hospital atmosphere softens the soldier and demoralizes him. I maintain, however, that through the prolonged neglect of a minor disability, the demoralization started before he entered the hospital, and it is increased on account of the ineffective treatment while there. There is a tendency to regiment treatment as if all cases of strain were alike, but there is all the difference in the world between an accidental strain occurring while a muscle is healthy and fresh and that which occurs *because* the muscle is tired and weak and overloaded with metabolites. In the former, active treatment from the beginning is desirable, but in the latter, the fatigued foot must be rested, and the toes maintained in the neutral position, in plaster if necessary. If not, contractures will occur before the muscle has recovered and manipulation or tenotomy will have to be done before a cure is effected.

**Dr. E. J. Crisp:** When a normal foot breaks down through fatigue or strain, rehabilitation is comparatively simple, and we usually return the soldier to his unit in an A 1 category. Unfortunately, the reverse does not hold true. When a foot with an inherent defect breaks down, no amount of physiotherapy can possibly make it an A 1 foot, and the most we can do is to restore it to its original condition. Until this important fact is appreciated the foot problem will remain. The medical profession rather tends to regard rehabilitation as a cure for every ill of the foot. Painful feet, not afflicted with obvious deformity, are generally regarded as normal, and vigorous physiotherapy and equally strenuous P.T. almost invariably ordered. Though the majority of cases recover under this routine, a not inconsiderable minority make no improvement or even become worse. The feet themselves, we shall find, have an infinite variety of shapes, and obviously many of them must be abnormal. The mistake we have made has been in approaching the problem with a textbook mentality, and regarding every foot as normal unless it has a classical defect.

We are all born with certain individual characteristics as regards build, wind, muscle power, co-ordination, elasticity, spring and capacity for work. These qualities are inherent and mainly unalterable, and apply no less to the foot than to any other part of the body. For this reason there will always be a number of recruits unable to adapt themselves to the modern military tempo.

In order to discover what constitutes a normal foot, the length and breadth of a series of feet under treatment were measured with a yardstick. This revealed considerable and significant variations in the "length to breadth ratio", the breadth being taken at the level of the metatarsal heads. The highest ratio met with, namely,  $3\frac{1}{2}:1$ , was found in an exceedingly narrow foot,  $9\frac{7}{8}$  in. long and only  $3\frac{1}{8}$  in. broad. The lowest ratio encountered was  $2\frac{1}{4}:1$ , in a foot  $9\frac{5}{8}$  in. long and  $4\frac{1}{8}$  in. broad. It is worthy of note that this second foot while being 1 in. wider was  $\frac{1}{4}$  in. shorter than the first. The authorities responsible for designing the Army boot were certainly not aware of this large variation in length to breadth ratio, for though it is supplied in three fittings for each size, some soldiers have feet so broad that they are compelled to wear boots two sizes too long in order to get the necessary width. In between the two extremes there were all varieties, but the great



majority of feet investigated had a length to breadth ratio of approximately  $2\frac{2}{3}:1$ . It was thus easy to divide the series into three types, namely: (a) The ultra-broad foot (ratio  $2\frac{2}{3}:1$ ); (b) the ultra-narrow foot (ratio  $3:1$  and over); (c) the intermediate or average foot (ratio  $2\frac{2}{3}:1$ ).

On applying this classification it immediately became clear that the ultra-broad foot gave uniformly bad results, the ultra-narrow foot very little better, but that the intermediate type almost invariably made a complete recovery. From this it became clear that for normal function a length to breadth ratio in the region of  $2\frac{2}{3}:1$  was desirable. It remained to discover what qualities were possessed by the average type foot which were lacking in the broad and the narrow.

*The normal foot.*—For a foot to perform satisfactorily, especially in the Army, it must possess certain inherent characteristics, largely qualitative, and if these are deficient, it will be liable to failure when submitted to any greatly increased activity. Let us consider what these essential qualities are.

The normal foot must be supple and mobile, it must have spring, resilience and elasticity. At the ankle-joint there should be at least 45 degrees of plantar flexion, and 10 to 15 degrees of true dorsiflexion, while it should be possible to obtain 60 degrees of inversion and 15 degrees of eversion. The foot should have a concave or at least straight instep and a moderate longitudinal arch, with anterior and posterior tibials capable of supporting it and allowing it to flatten at will; the outer border should be flat on the ground to assist in maintaining balance; the intrinsics must be competent to maintain correct function of the toes and above all there must be perfect muscular co-ordination. On the plantar surface there should be a reasonable layer of subcutaneous fat to provide padding for the heel and the metatarsal heads, the weight of the body should be evenly distributed between the heel and the ball of the foot and finally the length to breadth ratio should be in the region  $2\frac{2}{3}:1$ .

Before applying these characteristics to the three types of foot, we should consider the straight instep, the short tendo achillis and the high longitudinal arch. The first two are interdependent and will be discussed together.

*The straight instep and short tendo achillis.*—Limited dorsiflexion, secondary to a short tendo achillis is very common and directly responsible for many cases of "plano valgus" foot strain. In order to plantargrade the heel the forefoot becomes abducted and pronated, the instep assumes the characteristic convex outline, and the bones and ligaments adapt themselves to the new shape of the foot, the "spring ligament" remaining in a state of chronic strain.

Though feet with this deformity will often function satisfactorily when not unduly taxed, they soon give trouble in the Army. Experience shows that measures employed in peace time, such as raising the heel of the boot, do not succeed with service cases, and that vigorous rehabilitation is equally unsuccessful. The fact is that a short tendo achillis constitutes a serious defect in a soldier, which physiotherapy cannot remedy unless the individual is young and the condition slight. The logical treatment is a short stay in hospital until the feet recover to their original condition, followed by reggrading to category B 7.

*The high longitudinal arch.*—The foot with the high longitudinal arch, a type which before the war was looked upon with favour by many, should always be regarded with grave suspicion. It has a tight plantar fascia and plantar ligaments, with the result that normal mobility is restricted; thus the arch cannot flatten when the foot becomes fatigued, and strain is liable to occur. In addition, there is uneven distribution of weight, too much falling directly on the metatarsal heads. These two defects render the foot a potential casualty.

This kind of foot will function satisfactorily in a sedentary occupation, but under strenuous training is liable to break down. When this occurs there will be pain in the plantar fascia and under the metatarsal heads, clawing of the toes and callosity formation. As regards prognosis and treatment, unless the foot can be mobilized by manipulation so that the long arch can flatten in the normal manner, it will remain a defective foot, and be liable to break down again if the man returns to military activities on the previous scale. In this case, also, prolonged physiotherapy will be a waste of time, and the rational course will be just sufficient treatment to restore the foot to its original state, followed by reggrading to a lower category where it will be less liable to become strained.

The foot with an external arch, in addition to a high internal arch is occasionally met with. Though this type constitutes a powerful lever it is inefficient as a balancing agent, and is liable to develop a strain of the "cavo-valgus" variety. No kind of treatment is likely to improve it and it should be reggraded to B 7 on sight.

Under the supposition that the short tendo achillis and the high longitudinal arch have been excluded let us analyse the three types of foot, bearing in mind the qualities essential for normal function.

*The ultra-broad foot.*—When we inspect a foot of the ultra-broad type we shall note that not only is it extremely broad in proportion to its length, but also extremely thick. On its plantar surface we shall observe an exaggerated layer of subcutaneous adipose tissue, with the pads under the metatarsal heads so large that normal posturing of the toes is impossible. All movements of the foot, especially inversion and eversion, will be considerably limited and it will be generally stiff and lacking in elasticity. Attempts at the finer movements will be crude and there may be considerable inco-ordination. The individual himself will be of the thickset, stocky, muscle-bound type and his gait will be cumbrous, clumsy and lacking in spring. He is, in fact, like a heavy lorry; powerful but harshly sprung.

The foot is limited in mobility and elasticity, both by its shape and its thickness, and is symptomatic of the general muscle-bound condition of the whole body, and it is not unlikely that the thick layer of plantar fat is Nature's attempt to compensate for this. Spring is indispensable for normal walking and shock-absorbing, and on uneven ground mobility is essential if strain and trauma are not to occur. Thus we see that though this type of foot is powerful, it has serious defects.

The owner of this foot is a plodder rather than a walker, and can walk all day long without discomfort if allowed to plod along at his own speed. Likewise, he can do the heaviest day's work without fatigue; he is in fact a human carthorse. But when he joins the Army he is expected to perform like a racehorse, which is an impossible metamorphosis. He can no longer set his own pace, but has to march in step with the rest of the battalion. It is difficult for him to speed up his slow laborious gait to the quick Army tempo, and marking time on hard roads bruises his springless feet. It is little wonder that pain, fatigue and stiffness often develop until he can carry on no longer. There will be extreme tenderness under the metatarsal heads and in the plantar fascia, the intrinsic will be in spasm, and movements grossly inco-ordinated. There may in addition be aching in the midtarsal region and stiffness in the anterior tibial and calf muscles.

We have had more disappointments in the rehabilitation of this type than with any other, and will continue to do so until we realize that we are dealing with an abnormal foot, which is deficient in spring, mobility, and co-ordination. Attempts at re-education simply will not work. The man tries hard enough, but has not got the necessary cerebration to synchronize the various muscle groups, and the endeavour only leads to still greater confusion. The lack of spring and mobility is inherent and extensive exercises are powerless to remedy the condition. The "carthorse" type of foot has serious limitations and is best dealt with after breakdown by rest until pain, spasm and fatigue have gone, and then after a minimum of treatment regressing to category B 7.

*The ultra-narrow foot.*—The ultra-narrow foot is largely self-explanatory. We associate it with the individual of exceedingly poor physique, tall, lean, delicate and of the "human lamp-post" variety. The foot will have very indifferent musculature and be entirely devoid of subcutaneous tissue. The long arch may be well developed or absent, but mobility will, as a rule, be normal. Spring will be deficient owing to weakness and lack of tone in the anterior and posterior tibial groups, and this will predispose to valgus foot strain. In addition, the narrowness of the forefoot will not make for stability.

This type of man recognized his own limitations in peace-time and led an exceedingly sedate life, adapting his mode of living to his feet. On joining the Army he requires most carefully graduated training or acute valgus foot strain will result. Prolonged physiotherapy for this type of patient will seldom repay us for the time spent. After a period of rest and a limited course of remedial exercises, he should be regressed to a lower category where he will come to no further harm.

*The intermediate or average normal type foot.*—As has already been pointed out, feet of the intermediate type (length to breadth ratio  $2\frac{2}{3}:1$ ) invariably make excellent recoveries and it only remains to discover why. It is because they possess all the attributes necessary for normal function.

They have mobility, spring, co-ordination, a sufficient musculature and are correctly shaped. The individual himself, whether short or tall, will be of average proportions and physique. He will co-operate intelligently in his exercises and have little trouble in following the instructions of the masseuse. His feet will have broken down through fatigue, strain, or injury. In his early Army days fatigue due to ill-judged progression in

training is the likely cause. Later on in his Service career an exceedingly long route march may produce the same result, while severe trauma may occur on a battle course. But, whatever determines the breakdown, we have good material to work on and can proceed to rehabilitation with perfect confidence.

#### TREATMENT

It remains to discuss the treatment of the normal type foot, breakdown having usually resulted from a combination of fatigue and strain. When this occurs the soldier suffers a major disaster and he should be admitted to hospital immediately. The earlier the trouble is recognized and remedial measures instituted, the sooner will he be fit for duty. He will probably complain of pain along the inner border and in the sole of the foot, in the midtarsal region and under the external malleolus. The *tibialis anticus* will be fatigued, the long extensors overacting, the *intrinsic*s in spasm, the toes clawed or even cocked up, and all movements inco-ordinated. On standing there will be lack of tone in the *glutei* and he will be saggy at the knees with the *patellæ* rotated inwards. The development of the condition may have been rapid or a gradual one.

When the "fatigue-strain" syndrome is the cause, the soldier should remain in bed until his feet are rested, pain and spasm have gone, and there is complete relaxation. Only then may remedial exercises be commenced, the patient remaining in bed for several more days. Should the foot have been disabled by trauma, he must rest in bed until the swelling subsides, but exercises may be started at once.

Our aim will be to correct deformity or functional error by re-training certain muscle groups, dissociating various synergists, and synchronising contraction and relaxation. This will mean re-educating the *intrinsic*s and the *tibialis anticus* and teaching the latter muscle to dissociate itself from the long extensors of the toes.

When complete co-ordination has been restored, the patient may get up. The next step is to teach him to stand and walk correctly and to improve his balance. Stance, taken as meaning the position of the feet, and posture go together, and if stance is faulty posture must suffer, and vice versa. The commonest error of posture is the increased forward tilt of the pelvis secondary to atonicity of the *abdominals* and *glutei*. To correct this, the individual is instructed to pull his abdomen in and to contract his buttocks. This action not only twists the pelvis backwards, but produces external rotation of the thighs and brings the *patellæ* back to the mid-line. In addition, it causes reflex contraction of the *quadriceps* and *tibialis anticus*, bracing back the knees and lifting up the longitudinal arch so that the body-weight is rolled to the outer border of the foot. If this exercise is performed with the feet in the correct position, parallel and 4 in. apart, and the toes are pressed firmly on the ground, every muscle implicated in the breakdown will be re-trained and strengthened.

Having corrected the stance we proceed to re-education in walking. The method employed is simple, and aims especially at reinforcing the action of the *tibialis anticus*. With the feet held parallel or slightly intoed, the patient steps forward throwing his weight first on to the outer part of the heel and then on to the outer border of the foot, before rolling squarely on to the ball of the toes. Therefore, during the first part of every step the foot is held slightly in varus by the *tibialis anticus* which thus becomes still further conditioned.

Balance, though largely an inherent quality, can be considerably improved by graduated exercises. The *intrinsic*s will require stimulation by surging faradism, and care must be taken that the full range of mobility is regained. Every case presents a separate problem, and the individual attention of the masseuse is essential until re-education is completed and tone restored. Only then is the patient ready for class work, which should begin in the physiotherapy department. Later, he may be passed on to the sergeant instructor for foot work and light P.T., and as he improves, to full P.T., organized games and marches.

Rehabilitation used in this careful way will produce uniformly good results, the keynote of success being to allow the feet to become fully rested and relaxed before attempting any remedial exercise. Equally important is it to obtain the full co-operation of the patient by showing him kindness and consideration. Impatience will be our downfall; the feet have suffered severely and require a reasonable time to recover. As regards the length of time these cases should stay in hospital, we must be prepared to allow three to four weeks for a man with a moderate degree of the "fatigue-strain" syndrome, and upwards of six weeks or more if the condition is severe.

Mr. H. L.-C. Wood: This short paper represents the collective observations of several members of the surgical staff and of the physiotherapy department on foot cases seen in the out-patient department of a hospital.

The average civilian with foot strain will admit that he is better after a few weeks' rest and remedial exercises, whereas the same man, in uniform, will not admit anything of the sort. This attitude of mind can be explained by lack of the consulting-room atmosphere. In private practice or even in the civilian out-patient department, we take the trouble to explain briefly to the patient the reason for his symptoms and for the treatment prescribed. In other words, we seek his co-operation.

I do not suggest that even the majority of soldiers are of this type, but the fact remains that in hospital we see only the worst cases from the surgical aspect or the worst cases from the psychological aspect.

*Statistics.*—I have found that it is difficult to compile statistics of these cases, and still more difficult to follow up cases after discharge.

#### SERVICE CASES ONLY

*H.E.H. Out-Patient Department. May, 1941–September, 1942 (17 months).*

Total O.P. attendances = 1,687  
Total Foot cases = 869

% Foot cases = 50.8

Diagnosis	No. of cases	%
<i>Pes planus</i> (transverse and long arch) ... ..	276	31.8
<i>Callosities</i> ... ..	142	16.3
<i>Hallux valgus</i> ... ..	91	10.5
<i>Pes cavus</i> ... ..	65	7.5
<i>Hallux rigidus</i> ... ..	56	6.4
<i>Hammer toes</i> ... ..	41	
"Painful heel" ... ..	15	

Diagnosis	No. of cases	%
Painful feet	80	9.2
Metatarsalgia }		
March fractures	8	
Ingrowing toe nails	9	
Tinea infection (four months)	18	
Miscellaneous (fractures, congenital talipes, &c. ... ..	68	7.8

The proportion of foot cases is 50% of the total and of these a fallen long or transverse arch with or without callosities accounts for no less than 418 of the total, or again nearly 50%. Acute foot strain does not appear as we do not see the condition until the foot has broken down several times. *Pes cavus* is relatively uncommon. The large figure of 80 against "metatarsalgia" signifies that these cases were complaining of pain without obvious callosities, and as most were associated with a flattening anterior arch, they should be added to the already large total of 418. In fact these four types of pain account for no less than 498 cases or roughly 57% of all painful feet. *Hallux valgus* is next common, but this number, 91, includes cases referred for the deformity *per se*, irrespective of pain. March fracture appears 8 times. It is significant that not one had been previously diagnosed, and that men had frequently had severe pain for several weeks before being sent to hospital. The figure 18 for tinea infections of the foot is much too low. Tinea is a common cause of complaint of a burning, stinging, tired sensation, associated with a feeling of heat and sweating. Note that "painful heel" or plantar fasciitis was diagnosed in only 15 cases—a negligible proportion. Perhaps the explanation lies in the youth of most of these men.

In this survey I am ignoring obvious causes of pain, e.g. fractures, &c. included under the heading "Miscellaneous" numbering 68 in all.

I would call your attention to the complete absence of spasmodic or spastic feet which is what one would expect in men of Service age.

*Cause of pain.*—In the flat foot cases the cause of pain seems to fall into one of two main groups: (1) Muscles, ligaments, joints; (2) Pressure points.

(1) The pain originates in muscles, ligaments or joints and appears to be due to strain in early cases; to adhesions or arthritis in the more advanced. A shortened tendo achillis is found as a predisposing cause of pronation of the foot in many; extensor spasm with cocking of the toes is less common in our experience.

(2) The pain is situated over pressure points, i.e. metatarsal heads, bunions, corns or cocked toes, or prominence of internal cuneiform in "*pes cavus*". Other sources of discomfort are affections of the skin, e.g. tinea, excessive sweating or plantar warts.

Pain at the insertion of tendons, notably the *tibialis anticus* and *posticus* is sometimes a complaint. The latter is not infrequently associated with the presence of an *os tibiale externum*.

With such gross causes of pain as old fractures of the *os calcis* and other tarsal bones, I am not concerned, except to stress the importance of a radiogram in the diagnosis of a

painful foot. Obscure pain in fascia, ligament or joint may be due to oral or other septic foci.

*Causes of foot breakdown.*—A large number of men admit to some disability in previous civilian life. Even when employed in heavy occupation, the majority have not sought treatment until the strain of Army life has been superimposed on the already abnormal foot. In our experience a long route march is a more frequent cause of breakdown than drill or physical training, even when gym shoes are worn. The exception is hallux rigidus, which is usually aggravated by a soft rubber shoe, or by standing on the toes. In Guards Regiments, where a man may perform as many as 250 stamps a day, my impression is that foot troubles are more frequent, but this is only an impression. Ill-fitting boots are not frequently found and when they are it is usually a matter of depth or breadth rather than length. Normally an Army boot should be fitted two sizes larger than the measurement shown by the foot rule, but measurement must be taken in *full weight-bearing*.

The relative absence of foot trouble among officers may be accounted for by more careful selection before commission.

*Prevention.*—Can more be done in the early training of a recruit for the development of the muscles which control the foot, or is more attention paid to the trunk muscles to the detriment of the former group? I am aware that the Physical Training tables contain foot exercises designed to this end, but are they sufficient?

The second point of great importance is the early and efficient treatment of acute foot strain so that a more permanent breakdown does not develop. I am sure that neglect of this point is the cause of many later troubles. It is suggested that the young soldier does not like to report sick because of painful feet. It is something of which he is ashamed, and which he tries to conceal as long as possible. Thus to treat the breakdown in its early stages may be difficult.

*Treatment.*—This falls under five headings: (1) Footwear and supplementary appliances, such as crooked heels, pads, supports, &c. (2) Chiroprody. (3) Physiotherapy, including remedial exercises. (4) Manipulation. (5) Operation.

*Manipulation.*—The indications for manipulation are *pain*, plus *limitation of movement*, not necessarily amounting to rigidity. If the foot is obviously rigid, an X-ray should be taken to exclude osteo-arthritic changes as we do not believe that such feet are permanently benefited by manipulation.

To quote Bankart's technique, complete muscular relaxation is necessary and considerable force is required. We like to start active movements and massage as soon as the patient is sufficiently conscious to co-operate. We do not practise routine manipulation on all foot cases which are admitted for treatment, but try to obtain by examination a definite "lead" for this indication. The results of manipulation have been disappointing, even when obvious adhesions have been felt to break. Repeated small manipulations have likewise been a failure.

*Operative treatment.*—Excluding fractures and wounds, we have operated upon perhaps less than a dozen feet in Service cases, but have noted the results of operations done elsewhere in a larger number. Hallux rigidus cases account for many of these.

*Hammer toe* is a clear indication for operation, but it is seldom that a Service case is back to duty under eight to ten weeks.

*Tenotomy.*—In the few tenotomies for claw toes that have been seen, we have been struck by the oedema and fibrosis resulting and the little benefit derived; faulty technique or incorrect selection of the right moment to do the tenotomy may be the cause. Rest to alleviate muscle spasm is necessary before operation.

*Hallux valgus.*—Wherever possible the operation should be limited to removal of the exostosis. If arthritis makes removal of the bone necessary our preference is for removal of the metatarsal head rather than the phalangeal base. The point is that sufficient bone must be removed, and failures, particularly in hallux rigidus, are I think due to this fault. My own custom is to apply extension to the toe, by means of a Brock's pin and elastic for a week or ten days, not only to separate the joint surface, but also to maintain correction of deformity. Counter-traction is made by a light wire incorporated in a plaster shell. "After-treatment" consists of four weeks without weight-bearing, the last week being spent in remedial exercises and physiotherapy.

In making a decision for or against operation one must consider what incentive there is for quick recovery. It is our experience that young officers, and non-commissioned officers

of the higher ranks, respond to remedial and operative treatment far better than the rank and file. Members of the Women's Auxiliary Services who are coming under treatment in increasing numbers also do well. In fact the second lieutenant and the sergeant-major form the ideal subjects for treatment.

#### SUMMARY AND CONCLUSION

(1) More than half of the total of Service out-patient attendances at an E.M.S. Hospital are for disabilities of the foot.

(2) 57% of painful feet are associated with deformity of the anterior or longitudinal arches or with callosities.

(3) The majority have suffered minor foot disability prior to Army life.

(4) Long hours of marching or arduous training, rather than drill, or trades, is the precipitating cause of foot breakdown.

(5) Remedial treatment has, in our hands, been largely disappointing. This is, in part, due to lack of the incentive to get better; in part to the advanced type of case which is admitted to hospitals.

(6) Operative treatment is seldom indicated in the treatment of the Service foot, hammer toes, occasional tenotomies and removal of exostoses, being the only operations performed. In civilians, better results can always be obtained.

**Brigadier W. Rowley Bristow :** The subject of foot strain in relation to man-power and the wastage in the Army due to this cause is of real importance at the present time. With painful feet associated with marked structural defect I am not concerned. The gross deformities of severe hallux valgus and rigidus, or severe cavus with clawing of the toes, are not as a rule amenable to treatment as far as the serving soldier is concerned. The operations and necessary after-treatment which we are accustomed to carry out with success in peace-time do not restore men to the Army, or raise their category. The standard of physical fitness to make a man Grade A, i.e. fit to serve anywhere in the world, and to march any distance carrying a heavy pack, is a very high standard. To undergo the rigorous training of the modern infantry soldier throws an enormous strain on the feet, and incidentally on the knees too. There is a limit of attainment in these matters beyond which the average man cannot go. The soldier comes in great part from a more or less sedentary civilian life, and with the higher age-groups now being taken in, great care is needed if the intake is going to stand up to training.

A large number of men taken into the Service will never make infantry soldiers but could well be employed as drivers or personnel in tank units, and an effort is being made to sort these men out at an early stage and try and fit them into that branch of the Service in which they are likely to make good. The types of feet, and of posture generally, preclude the possibility of developing a percentage of the intake to the degree of physique necessary for a professional football player, which would appear to be the standard required in modern infantry.

In the Army Bulletin, a short article was published for the guidance of medical officers, pointing out the special need to watch for pain on the dorsum of the foot and tenderness of the tibialis anticus. There is an even commoner cause of pain in the mobile foot subjected to overstrain, viz. the weakness of intrinsic muscles giving rise to metatarsalgia. If the intrinsics tire, the soldier can no longer stretch the toes, he bears weight on his metatarsal heads, his toes curl and are rubbed by the upper of the boot. Pain under the plantar ligaments seems to occur most frequently in feet which are weak but still mobile. It is the recognition of the early stage of foot strain which is the essential work of the Unit medical officer, who is usually a newly qualified man.

Orthopædic surgeons—both in the Service and outside it—must do all they can to instruct the younger generation of medical men in this important subject. They must investigate the whole general condition of a patient complaining of foot strain, and they must regard the foot not as an isolated unit but as part of the general postural mechanism of the body, and recognize the early stages of the breakdown of this mechanism.

Those patients who do not rapidly improve should be brought before an orthopædic surgeon. In my experience, many of these men do not see an orthopædic surgeon at all. They are put on to treatment which means physical treatment and exercises when what many of them need is rest. This preliminary period of rest, without weight bearing, is

often a necessary stage in treatment. After a week or two the exercises under supervision to build up the musculature, especially of the intrinsics, first non-weight bearing and later with weight bearing, follow on. This necessitates institutional treatment because many soldiers are now in billets and the mere walk to and from their cookhouse militates against treatment of foot strain in the stage we are considering. It is obviously a serious problem to invalid, even temporarily, men with what may seem a small disability, but in my opinion it is justified and is necessary if wastage is to be avoided.

Every man complaining of foot disability does not need hospitalization, but the M.O. should apply to the orthopædic surgeon for advice in doubtful cases and we, as orthopædic surgeons, should remember that rest is the essential preliminary to active treatment for many patients. We must be very careful in the selection of these patients, or the hospital beds will be full of men complaining of foot disability, a large number of whom could be put right in the unit with the aid of the local chiropodist.

**Mr. W. H. Gervis:** If a properly articulated skeleton of a foot is examined it will be seen that the articular facet on the cuboid for the cuneiform is nearly horizontal. Therefore the third cuneiform carrying the second and the first rests upon it, so that the arch of the foot in this situation cannot be directly depressed. If, however, the astragalus is rotated medially, its head carries the navicular and cuneiforms medially and depresses them, and the condition of pes plano-valgus is produced. It is therefore not possible to have a pure pes planus, but only a plano-valgus.

In life the usual cause of inward rotation of the astragalus is walking with the feet turned out. The commonest cause of this in the young appears to be a stiff proprietary shoe with a crooked heel, and in adults military training.

The plano-valgus deformity is also produced by eversion of the os calcis, as in the talipes valgus deformity so common in children.

The importance of the intrinsic muscles was mentioned by Dr. Crisp. In a high-heeled shoe the toes are kept permanently dorsiflexed. Even in an ordinary man's shoe the heel is sufficient to dorsiflex the toes and this is increased by the upward curve of the forepart of the sole under the toes. The result is that the proximal phalanges of the toes are dorsiflexed and cannot be plantiflexed, so that the normal function of the interossei and lumbricales is not possible.

Another point is that patients frequently complain of pain about the head of one metatarsal, which on examination is found to be the longest, the second being most commonly affected. When such a foot is standing flat all the metatarsal heads rest equally on the floor. When, however, the heel is raised as in a heeled shoe the head of the longest metatarsal must take the greater weight. This is easily demonstrated with a hand, which will rest flat on a table but if the wrist is raised it rests then only on the tip of the third finger. In these cases the proximal phalanx of the affected toe is usually more dorsiflexed than the others and cannot be flexed owing to adhesions, so that a manipulation is needed to get full range. A short first metatarsal is considered abnormal by some and blamed for these troubles, but on examination of 100 radiograms of normal feet the first metatarsal was longer than the second in 19 only.

Faradic foot baths can do no good if the toes are clawed. Faradism to the lumbricales and interossei must be given with the foot on a block which reaches forward as far as the metatarsal heads. The patient then exerts sufficient pressure to straighten the toes and correct the dorsiflexion of the proximal phalanges, so that these muscles can exert their proper action.

## Section of Obstetrics and Gynæcology

President—DAINE LOUISE McILROY, D.B.E., M.D.

[October 16, 1942]

### DISCUSSION ON STILLBIRTH AND NEONATAL MORTALITY

Professor D. Baird: On making a statistical analysis great differences are found in the stillbirth and neonatal mortality rate as between one country and another and between different areas of the same country. In 1936 in England and Wales there were 25,045 stillbirths and 18,200 neonatal deaths, a total of 43,245. This compares with 28,000 deaths from tuberculosis and 56,000 from cancer. The figure for Scotland shows a similar tendency. The stillbirths and neonatal deaths in Scotland are approximately equal, individually exceeding the combined deaths from scarlet fever, measles, whooping-cough and diphtheria, and as the expectation of life at birth is nowadays about 60 years, we see that the effective years of life lost are very great.

It has been recognized for a long time that the infantile mortality rate is largely dependent on poverty and a low standard of living, and the stillbirth and neonatal death-rates may be similarly influenced. A study of the Registrar-General's reports shows that for certain years, as we go down the social scale, infant mortality increases from 38 per 1,000 births among the well-to-do to 103 per 1,000 among the lowest class economically—the "unoccupied". The neonatal mortality is similarly affected, varying from 22 per 1,000 in the upper and middle class to 55 in the "unoccupied".

A great deal can be learned from a statistical study of biological groups, and a recent publication by Mrs. C. M. Burns entitled "Infantile and Maternal Mortality in Relation to Size of Family and Rapidity of Breeding" (Carr, Newcastle-on-Tyne, 1942) is of great interest. She shows that there is a steady rise in the stillbirth rate with the age of the mother and also a decrease with parity, except in cases in which there is a parity of seven or over. The neonatal mortality rate is similarly influenced. Another factor is the influence of the rate of reproduction. At each size of family there is a maternal age which gives the children the greatest chance of survival. It is important in shaping national policy that the conclusions to be drawn from this valuable contribution should be carefully studied.

The exact cause of stillbirth is often difficult to determine, especially in domiciliary practice, and even in a hospital with the aid of routine post-mortem examinations it is often difficult to make a diagnosis. The appendix to the Registrar-General's report for 1939 dealing with Scotland gives his estimate of the main causes of stillbirth in order of relative importance. He classifies 27% as ill-defined and 10% as of unknown cause. In 37% of the cases therefore he could not determine why the baby was not born alive. Then 14% of the deaths were due to difficult labour, 13% to foetal deformities, and the other causes are ante-partum hæmorrhage, toxæmia, and general diseases.

MacGregor in Edinburgh drew attention to the high incidence of pneumonia not only in the neonatal period but also amongst stillbirths. I have made an analysis of stillbirths and neonatal deaths, in "booked" cases, in the Aberdeen Maternity Hospital, and as it is the only maternity hospital in the area it should give a satisfactory cross-section of the death-rates in the City during the period investigated. The stillbirth rate was about 33 per 1,000 births, and the causes of death corresponded fairly well with those given in the Registrar-General's statistics. The biggest individual factor was again "cause unknown". In 30 cases out of a total of 82 the cause could not be identified. In 24 cases the cause was difficult labour, in 9 toxæmia, in 6 accidental hæmorrhage, in 5 foetal deformities, and in one placenta prævia. There was also a miscellaneous group of 7.



With regard to the stillbirths following difficult labour very few are avoidable since many are due to prolapse of the cord and uterine dysfunction.

Premature babies are much more liable to die during the course of labour and every effort should be made to prevent prematurity. Of 65 stillbirths in premature babies the cause of the premature onset of labour was undetermined in 21, in 11 it was due to toxæmia, in 11 to intercurrent disease, in 6 to accidental hæmorrhage and in 6 placenta prævia.

In emergency cases difficult labour is frequent, and if placenta prævia is added to difficult labour, nearly 50% of the cases are accounted for. Some of these deaths could have been avoided if the patient had been admitted earlier to hospital. Toxæmia was the most common cause of the onset of premature labour in emergency cases.

*Neonatal mortality.*—In Scotland at any rate, 50% of infantile deaths occur during the first month of life, and faulty feeding during this time leads to marasmus and increased susceptibility to infection later. Neonatal mortality varies greatly from one country to another, and also within the same country. In 1937 the neonatal rate of mortality was 38 per 1,000, in the North of England 34, in the South East of England 24, and, taking large cities, it varied from 43 in Glasgow to 24 in London. The London figure is about the same as for New York and Chicago.

Amongst "booked" hospital cases almost half of the deaths in full-time babies were due to infection, but most of these occurred after dismissal from hospital and are avoidable. Few of the remainder are avoidable. Half of the neonatal deaths were in premature babies, and the mortality amongst premature babies (under 5½ lb.) varies directly with the birth-weight. As with stillbirths the cause of the premature onset of labour could not be determined in almost 40% of cases. In emergency cases trauma again accounted for 50% of the deaths in full-time babies and in premature babies there was a very large number in which the premature onset of labour seemed unavoidable in the present state of knowledge. The prevention of prematurity is an urgent problem and until this can be solved the best possible provision must be made for the nursing of premature babies. The better the care the higher the survival rate. Many are so feeble, however, that survival is impossible. Out of a series of 67 neonatal deaths in premature babies 45 died within three days of birth, due to weakness.

The incidence of premature labour in the "booked" hospital cases which represent the working-class community is about 9%. In a series of 885 cases in the upper and middle class the incidence of prematurity was 6%, and in a series of 330 "booked" specialist cases the premature birth-rate was 2%. The neonatal mortality of these three groups was respectively 3.3, 1.35, and 0.6. In the two latter groups the good figures were due to the absence of infection and to the fact that of the premature babies few were very small.

Where the neonatal mortality is low the stillbirth-rate is also low. In the specialist series already mentioned the stillbirth-rate was also 0.6 per cent. The fact that the stillbirth-rate in hospital, where obstetric care is good, is relatively high, 3.3%, suggests that social status is important, and the factor most likely to affect the rates is the diet of the mother. This is supported by recent Toronto feeding experiments. A supplementary ration reduced the prematurity rate from 8% to 2.2% and the stillbirth-rate from 3.4% to nothing.

Stillbirths and neonatal deaths as well as infant deaths in general have much higher rates in Scotland than in England. Sixty years ago the positions were reversed. Presumably, therefore, there is no inherent weakness in Scottish offspring. Housing is much worse in Scotland and there is much more poverty.

There is a vast amount of work dealing with the subject in animals and there is no doubt that the literature of animal experiments should be more widely known amongst obstetricians. The relatively prosperous parts of the country are solving the infant mortality by so reducing the size of their families that they are failing to reproduce themselves. In the depressed areas the birth-rate is much higher, but the stillbirth and neonatal mortality rates are high because of malnutrition, too rapid child-bearing and slum conditions generally. The net reproduction rate in these areas is about 0.9.

In a depressed area the following measures would lower the mortality: (1) better feeding of pregnant women and nursing mothers, together with more rest; (2) better health instruction and intensive mothercraft teaching during pregnancy; (3) the provision of more antenatal beds in hospital for treatment of complications; (4) better post-graduate training of doctors and nurses; (5) better training of health visitors.

In the more prosperous areas the chief problem is to check the fall in the birth-rate. The country must realize that its real wealth is in the quality of the young people whom it produces. Recent surveys have shown that over 50% of children are reared in conditions of primary poverty.

Professor Charles McNeil : I propose to make some practical suggestions for the study and reduction of infant deaths during birth and the first month of life.

*Inclusion of stillbirths.*—It is necessary to place alongside any figures of neonatal mortality the corresponding stillbirths. This is especially important in any international comparisons of infant mortality rates. Unless this is done, serious errors in the calculation of infant deaths will be made. Further, the dividing line between stillbirths and neonatal deaths, usually so sharply drawn, is misleading, because the same lethal processes that destroy infant life during birth, continue to operate with great power after birth, and indeed are responsible for the majority of neonatal deaths. To illustrate these points, statistics of 5,300 viable births in the Simpson Maternity Pavilion of the Edinburgh Royal Infirmary during 1939 and 1940 are presented. The figures of viable births and deaths are shown in graphic form in 3 charts; and these charts give broad but accurate impressions of three problems in a large maternity hospital:—the conglomerate mass of stillbirths and neonatal deaths which is the total problem of our discussion (fig. 1); the proportions of stillbirths and of neonatal deaths (fig. 2); and the division into maturity and prematurity, showing for each group a separation of stillbirths and neonatal deaths (fig. 3).

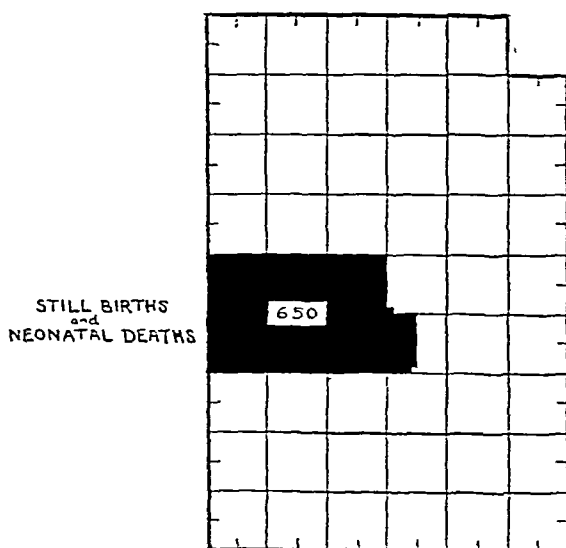


FIG. 1.—Maternity Pavilion, Royal Infirmary, Edinburgh.  
Deaths (stillbirths and neonatal deaths) in 5,300 viable births,  
1939-40.

Fig. 2 shows the splitting of the single block of infant deaths into stillbirths and neonatal deaths, and the great preponderance of stillbirths. When we remember that many of the deaths in the neonatal block are due to the same causes that produce stillbirth, it is clear that the problem of stillbirths is the greatest part of the whole problem of natal and neonatal death.

*Prematurity.*—The standard of prematurity (or immaturity) for this series is the Geneva weight standard of  $5\frac{1}{2}$  lb. In fig. 3, the *prematures* are placed at the bottom of the chart, and include stillbirths, neonatal deaths, and survivors, with a total death-rate (including stillbirths) of 53%: above them are placed the great mass of *mature viable births* with a total death-rate of 6.5%. The incidence of prematurity in this hospital series is 12%. This chart shows that any serious effort to reduce infant deaths in the first month must include a special and separate study of prematurity, the discovery and control of its causes, and a more successful management of the premature baby after birth. This series of 653 prematures includes 68 under  $2\frac{1}{2}$  lb., all of whom died.

The introduction of a weight standard for prematurity has been of great value in allowing accurate comparison between published series of cases; but it is essential that premature stillbirths should be included in all studies of prematurity. It would be also of great value to have a lower weight standard in prematurity, all under  $2\frac{1}{2}$  lb., being placed in a separate pre-viable group.

*Pathological causes of death during birth and in the first month.*—Post-mortem examination was carried out in 541 cases of the 650 deaths in this series. They were done by Dr. Agnes Macgregor. This large number of autopsies by an experienced pathologist allows the accurate grouping of the pathological conditions that were the immediate causes of death. These causes fall into six groups, *gross congenital defects, asphyxia, intracranial hæmorrhage, infections, miscellaneous, and unknown* (in stillbirths, this was

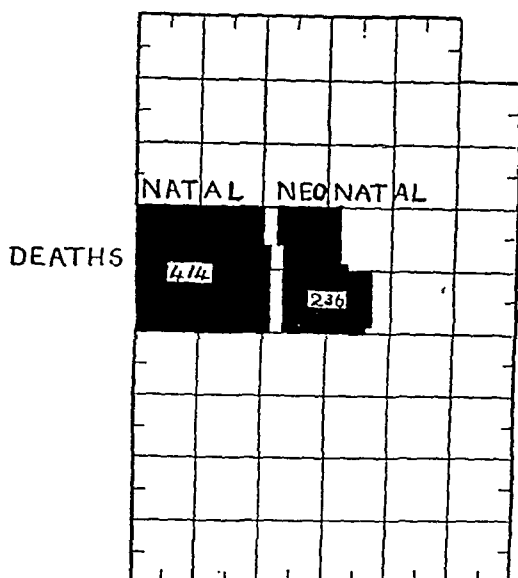


FIG. 2.—Stillbirths and neonatal deaths in 5,300 viable births.

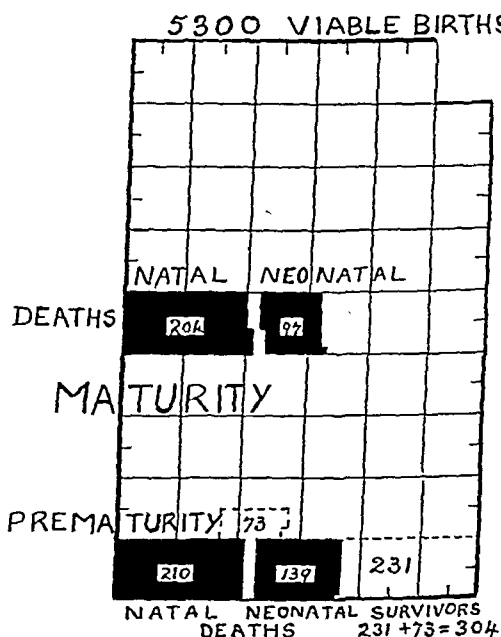


FIG. 3.—Maturity and prematurity.

nearly always maceration). The results are given in the following table as death-percentages for the four clinical groups; mature stillbirths and neonatal deaths; and premature stillbirths and neonatal deaths.

Pathological condition	Mature	
	(Autopsies 163) Stillbirths	(Autopsies 95) Neonatal deaths
Congenital defect ... ..	11	21
Asphyxia ... ..	49	19
Intracranial hæmorrhage ... ..	26	13
Infections ... ..	0	31
Miscellaneous ... ..	0	11
Unknown ... ..	13	2

Pathological condition	Premature	
	(Autopsies 153) Stillbirths	(Autopsies 130) Neonatal deaths
Congenital defect ... ..	25	4
Asphyxia ... ..	42	37
Intracranial hæmorrhage ... ..	10	15
Infections ... ..	0.7	23
Miscellaneous ... ..	4	5
Unknown ... ..	17	16

Comment may be made upon the more important facts disclosed by this table.

*Congenital defects* account for a considerable number of deaths both in matures and prematures; but the incidence of fatal congenital defects is about nine times greater in the premature than in the mature group.

*Asphyxia* is the predominant cause of death both in matures and prematures; and especially so, in prematures.

*Infections* only caused one death in all the stillbirths; but they took a high place both

in the mature and premature neonatal deaths. The principal fatal infection was gastro-enteritis; respiratory infections and thrush also played a considerable part. Fatal infection of the umbilical wound, and destructive infection of the eye, formerly common in maternity hospitals, are now rare, although minor surface infections are still prevalent. But the high incidence of fatal alimentary and respiratory infections shown in this series is probably occurring in other maternity hospitals and nursing homes where the newborn are congregated; and with the steady increase of institutional midwifery, the problem of fatal neonatal infection remains serious and demands further study and stricter measures of notification and control.

*Allocation of the infant clinical problems of the first month.*—As regards study and control, these problems fall either to obstetrics or to pædiatrics.

The allocation to *obstetrics* includes, congenital defects; asphyxia and intracranial hæmorrhage, with their causes; and the great predisposing condition of prematurity which entails a study of the general health of pregnant women. These clinical conditions form the largest and the most intractable part of the total problem of stillbirths and neonatal deaths. But obstetrics, which is perhaps the best organized of the primary subjects of medical practice, is well equipped to grapple with its share of this hard problem; and already hopes have been raised that improvement of the diet in pregnancy can substantially reduce the incidence of prematurity. If these hopes are realized, a reduction of prematurity will bring down appreciably the natal and neonatal death-rate.

The *pædiatric clinical problems* are: The care of the premature baby after birth; the countering of neonatal hospital infection; and the inauguration and management of feeding. Our present management of these three problems leaves much room for improvement; and yet all these problems are amenable to measures of control as has been shown by the reduction of premature neonatal deaths in Chicago, and the improved nursing hygiene in the newborn nurseries of New York. British pædiatrics is poorly equipped to deal with these big problems. The first urgent requirement is the strengthening of pædiatric staffs in maternity hospitals.

#### SUMMARY

In the neonatal period, stillbirths and neonatal deaths present a conjoint clinical problem.

One part, which is obstetrical, involves the study of conditions that occur during birth and also go back to the period of pregnancy; while the pædiatric problem, covering the first weeks after birth, continues and extends into the succeeding weeks and months.

This double problem, obstetrical and pædiatric, is therefore not confined in time to the first month, nor can it be studied completely in maternity hospitals. It requires study of the food and other home conditions of the expectant mother as well as the highest standards of obstetric care during pregnancy and labour. It also requires the successful inauguration of baby feeding in the maternity hospital; the protection of the baby from the great danger of hospital infection; and more than that, the continued mastery of infant dietetics at home during the first year, and the maintenance of conditions in the home that will raise a barrier against the dangers of infection there.

In the obstetrical problem, created by infant deaths during birth and in the succeeding weeks, there are two main keys to its solution—the nutrition and diet of the mother during pregnancy, and skilful management of labour. In the pædiatric problem the main keys are again two—the nutrition and diet of the baby, and the prevention of infection.

The first month of life is therefore of the highest importance as regards the health of the mother and child. The health of the mother *before and after birth*, is bound up with the health of the child. This conjoint problem of maternal and child health constitutes the main foundation of national health.

#### RECOMMENDATIONS

- (1) Increase of pædiatric staffs in maternity hospitals.
- (2) Planned studies in maternity hospitals of the infant problems which occur in the first month.
- (3) A uniform and more complete reporting of statistics of stillbirths and live births in maternity hospitals which would be of great value in promoting these studies.
- (4) Agreed standards of prematurity should be adopted by maternity hospitals—the inclusion of stillbirths, and an upper and lower weight standard.
- (5) In selected hospitals radical investigations of the problem of prematurity should be carried out by medical teams consisting of obstetricians, pædiatricians and patholo-

gists; these investigations centred in the hospitals, but extending into homes and home conditions during pregnancy, and after discharge of mothers and babies from hospital.

(6) The question of notification of neonatal hospital infections, and especially gastro-enteritis, should be considered.

(7) Infant follow-up clinics should be attached to all maternity hospitals.

(8) In order to close the disastrous gap in medical and nursing supervision of the baby that occurs in the second week in hospital and home midwifery, when the mothers resume their household duties and the attendance of obstetrician and midwife ends, there should be *continuous and much closer supervision of babies, born in hospital or at home, throughout the first month* by doctors and nurses well instructed in the baby problems of the first month, and especially as regards dietetics and hygiene.

I wish to make grateful acknowledgment to Dr. Agnes Macgregor for her valuable post-mortem records, and to Dr. J. L. Henderson for his laborious and accurate compiling and analysis of the figures.

Sir Francis Fremantle, M.P., said that the infant mortality rate and the maternal death-rate which caused so much anxiety in England, and still more in Scotland, but so little perturbation in Holland and other countries, must be related to a common set of causes. Attention was markedly directed to these matters by the passing of the Midwives Act, 1902; by the Report on Maternal Mortality presented to Parliament in 1937; by the Joint Council of Midwifery, which started in 1935, dealing particularly with the work of midwives, and by the reports on maternity nurses and on abortion. Maternity nurses were often in the same position as midwives as they were left largely responsible for the condition of their patients for the greater part of the time.

The conditions of war had brought these matters sharply home to the authorities and to the public. One of the difficulties was to find an adequate number of women to undertake the work, and to make it sufficiently attractive for them to remain and to keep them up to the mark. It might be hoped that in due course midwives, on the report of the Rushcliffe Committee, soon to be expected, would enjoy a position comparable with teachers, whose position had been so greatly improved by the Burnham scale.

The Ministry of Health had lately produced its annual report. After dropping to the low figure of 2.6 per 1,000 births in 1940, the maternal mortality rate had risen slightly, but the rate of infection during childbirth and the puerperium and the figures for puerperal sepsis had fallen during the last two years. Infant mortality had risen by 3 points over that for 1940 and 9 points over the record low figure for 1939; but the neonatal mortality rate had fallen a little and the stillbirth rate which in 1938 was 38 per 1,000 births, declined to 35 last year, again a low record; so that despite the war there had been improvement in that respect.

There are now 1,860 antenatal clinics showing 452,000 attendances last year. The first visits paid by health visitors—a new profession of great promise—numbered over half a million. But a good deal remained to be done in improvement of these antenatal clinics and in the training and selection of health visitors. Feeding arrangements for expectant and nursing mothers had also been improved, and these might be expected to have a considerable effect in reducing the stillbirths and neonatal mortality rates. But housing, economic welfare, and institution accommodation, all influenced the position; the war would bring about a large forward movement in these directions; and he hoped any extension of the institutional care of mothers, would not take away from them their sense of individual responsibility and their duty of self-help.

Poverty and housing had come largely into the picture. In these investigations it was found as a rule that alarming conditions reflected in the infant mortality rates were associated with poverty. The economic conditions which created poverty were to a certain extent the result in present or previous generations of ignorance and weakness in the individual and the fact that the weakest had inevitably gone to the wall. It was not merely the conditions under which they lived but also their natural weakness in breed, character, or intelligence, which produced the deplorable statistics.

The desired advance would not result merely by improving housing conditions. They all knew of people who lived in slums in conditions of penury and insanitation and yet, because the housewife was scrupulously clean and a good manager, a healthy family was brought up.

It was most important to teach the people themselves how they could develop their own powers and help their own prospects. That would be a better method of reform than all the proposals which came before them in Parliament.

**Dr. Doyne Bell :** In a discussion of maternity services held by this Section earlier in this year one speaker was reported as saying that "it was logical to take the maternal mortality rate as a yardstick by which to measure the quality of the service" (Holland, 1942). But the baby is no mere by-product of the service and the stillbirth rate and the neonatal death-rate are two very useful yardsticks for measuring its success.

A recent editorial in the *Lancet* (1942) said that the first month was the beginning of pædiatrics; yet in the new Maternity Services Act there was no specific provision for the expert pædiatric control of the baby in these first dangerous weeks after birth; there was in fact no pædiatrician on the Central Midwives Board.

This editorial was prompted by an article by Miller (1942) based on a report by Spence and Miller on the causes of infantile death, and stressed the inaccuracies of certification of such deaths. One point among the many which emerged from this report was that up till 1940 "Prematurity was preferred to almost any other cause of death in infancy". Prematurity should be used to imply birth before full expected term, and Immaturity birth while the infant is relatively ill-equipped for extra-uterine life. Prematurity has been defined as birth before the 40th week of gestation, and immaturity can be usefully gauged by the weight of the infant and has been arbitrarily defined as an attribute of infants weighing less than 5½ lb. at birth.

The work carried out in Toronto (Ebbs *et al.*, 1941, 1942) has already been referred to and, as it has been hailed as showing that, with proper feeding of poor women, infant mortality can be almost abolished, it seems worth while to examine such a startling claim. The general scheme of this work was to study the performances in child-bearing of two groups of mothers, one on a "Poor Diet", and the other on a "Good Diet". It was soon appreciated that these two groups were not comparable, so the "Poor Diet" group was divided into two, one of which had their diet supplemented to the standard of the original "Good Diet" group. The past obstetrical history of the multiparæ in these groups is given in Table I (Ebbs *et al.*, 1941). The multiparæ constituted 65%

TABLE I. (From *The Journal of Nutrition*, 1941, 22, 522.)

Past obstetrical history of multiparous patients (% of cases)	Poor diet (1)	Supplemented good diet (2)	Good diet (3)
Abortions	13.1	4.7	9.0
Miscarriages	38.1	39.0	24.4
Prematures	10.7	20.3	13.3
Stillbirths	9.5	4.7	2.2

and 71% of the first two groups respectively. It will be seen at once that these two series differ so widely that neither constitutes a control series for the other.

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TABLE II. (From *The Canadian Med. Assn. Journal*, 1942, 46, 8.)

	Poor diet (1)	Good diet Supplemented (2)	Good diet (3)
Total patients observed	120	90	170
Miscarriages	7	0	2
Stillbirths	4	0	1
Deaths recorded in first 250 babies followed up to 6 months	3	0	0
	14	0	3
Congenital malformation	1	2	1

conclusion that three infant deaths out of an unstated number in the "Poor Diet" group against no death out of an unstated number in the "Supplemented Good Diet" group is of any significance, it is clearly justifiable to conclude that double the number of congenital malformations in the "Supplemented" group is significant, which is highly improbable.

A research also addressed to the problem of the effect of diet upon the infant was initiated before the war by the People's League of Health, and an interim report has been published in the *B.M.J.* and the *Lancet*. Unfortunately the concept of prematurity, defined as birth before the 40th week of gestation, has been used as a yardstick to measure the success of the changed diet. In order to try to assess the suitability of such a yardstick for this purpose, I have, with the permission of Mr. Eardley Holland, taken a

gists; these investigations centred in the hospitals, but extending into homes and home conditions during pregnancy, and after discharge of mothers and babies from hospital.

(6) The question of notification of neonatal hospital infections, and especially gastro-enteritis, should be considered.

(7) Infant follow-up clinics should be attached to all maternity hospitals.

(8) In order to close the disastrous gap in medical and nursing supervision of the baby that occurs in the second week in hospital and home midwifery, when the mothers resume their household duties and the attendance of obstetrician and midwife ends, there should be *continuous and much closer supervision of babies, born in hospital or at home, throughout the first month* by doctors and nurses well instructed in the baby problems of the first month, and especially as regards dietetics and hygiene.

I wish to make grateful acknowledgment to Dr. Agnes Macgregor for her valuable post-mortem records, and to Dr. J. L. Henderson for his laborious and accurate compiling and analysis of the figures.

Sir Francis Fremantle, M.P., said that the infant mortality rate and the maternal death-rate which caused so much anxiety in England, and still more in Scotland, but so little perturbation in Holland and other countries, must be related to a common set of causes. Attention was markedly directed to these matters by the passing of the Midwives Act, 1902; by the Report on Maternal Mortality presented to Parliament in 1937; by the Joint Council of Midwifery, which started in 1935, dealing particularly with the work of midwives, and by the reports on maternity nurses and on abortion. Maternity nurses were often in the same position as midwives as they were left largely responsible for the condition of their patients for the greater part of the time.

The conditions of war had brought these matters sharply home to the authorities and to the public. One of the difficulties was to find an adequate number of women to undertake the work, and to make it sufficiently attractive for them to remain and to keep them up to the mark. It might be hoped that in due course midwives, on the report of the Rushcliffe Committee, soon to be expected, would enjoy a position comparable with teachers, whose position had been so greatly improved by the Burnham scale.

The Ministry of Health had lately produced its annual report. After dropping to the low figure of 2.6 per 1,000 births in 1940, the maternal mortality rate had risen slightly, but the rate of infection during childbirth and the puerperium and the figures for puerperal sepsis had fallen during the last two years. Infant mortality had risen by 3 points over that for 1940 and 9 points over the record low figure for 1939; but the neonatal mortality rate had fallen a little and the stillbirth rate which in 1938 was 38 per 1,000 births, declined to 35 last year, again a low record; so that despite the war there had been improvement in that respect.

There are now 1,860 antenatal clinics showing 452,000 attendances last year. The first visits paid by health visitors—a new profession of great promise—numbered over half a million. But a good deal remained to be done in improvement of these antenatal clinics and in the training and selection of health visitors. Feeding arrangements for expectant and nursing mothers had also been improved, and these might be expected to have a considerable effect in reducing the stillbirths and neonatal mortality rates. But housing, economic welfare, and institution accommodation, all influenced the position: the war would bring about a large forward movement in these directions; and he hoped any extension of the institutional care of mothers, would not take away from them their sense of individual responsibility and their duty of self-help.

Poverty and housing had come largely into the picture. In these investigations it was found as a rule that alarming conditions reflected in the infant mortality rates were associated with poverty. The economic conditions which created poverty were to a certain extent the result in present or previous generations of ignorance and weakness in the individual and the fact that the weakest had inevitably gone to the wall. It was not merely the conditions under which they lived but also their natural weakness in breed, character, or intelligence, which produced the deplorable statistics.

The desired advance would not result merely by improving housing conditions. They all knew of people who lived in slums in conditions of penury and insanitation and yet, because the housewife was scrupulously clean and a good manager, a healthy family was brought up.

It was most important to teach the people themselves how they could develop their own powers and help their own prospects. That would be a better method of reform than all the proposals which came before them in Parliament.

Dr. Doyne Bell: In a discussion of maternity services held by this Section earlier in this year one speaker was reported as saying that "it was logical to take the maternal mortality rate as a yardstick by which to measure the quality of the service" (Holland, 1942). But the baby is no mere by-product of the service and the stillbirth rate and the neonatal death-rate are two very useful yardsticks for measuring its success.

A recent editorial in the *Lancet* (1942) said that the first month was the beginning of pædiatrics; yet in the new Maternity Services Act there was no specific provision for the expert pædiatric control of the baby in these first dangerous weeks after birth; there was in fact no pædiatrician on the Central Midwives Board.

This editorial was prompted by an article by Miller (1942) based on a report by Spence and Miller on the causes of infantile death, and stressed the inaccuracies of certification of such deaths. One point among the many which emerged from this report was that up till 1940 "Prematurity was preferred to almost any other cause of death in infancy". Prematurity should be used to imply birth before full expected term, and Immaturity birth while the infant is relatively ill-equipped for extra-uterine life. Prematurity has been defined as birth before the 40th week of gestation, and immaturity can be usefully gauged by the weight of the infant and has been arbitrarily defined as an attribute of infants weighing less than 5½ lb. at birth.

The work carried out in Toronto (Ebbs *et al.*, 1941, 1942) has already been referred to and, as it has been hailed as showing that, with proper feeding of poor women, infant mortality can be almost abolished, it seems worth while to examine such a startling claim. The general scheme of this work was to study the performances in child-bearing of two groups of mothers, one on a "Poor Diet", and the other on a "Good Diet". It was soon appreciated that these two groups were not comparable, so the "Poor Diet" group was divided into two, one of which had their diet supplemented to the standard of the original "Good Diet" group. The past obstetrical history of the multiparæ in these groups is given in Table I (Ebbs *et al.*, 1941). The multiparæ constituted 65%

TABLE I. (From *The Journal of Nutrition*, 1941, 22, 522.)

Past obstetrical history of multiparous patients (% of cases)	Poor diet (1)	Supplemented good diet (2)	Good diet (3)
Abortions ... ..	13.1	4.7	9.0
Miscarriages ... ..	38.1	39.0	24.4
Prematures ... ..	10.7	20.3	13.3
Stillbirths ... ..	9.5	4.7	2.2

and 71% of the first two groups respectively. It will be seen at once that these two series differ so widely that neither constitutes a control series for the other.

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random series of 147 babies born in the London Hospital in 1938 and 135 babies born in 1942 and have made a histogram of their estimated gestation periods (fig. 1). It will be seen that in 1938 the estimated gestation periods are distributed normally about the 40th week with a standard deviation of approximately  $\pm$  ten days, that is between 3% and 4%.

This observation leads to the expectation that  $\frac{1}{8}$  of all normal gestations will terminate before the 40th week. I venture to suggest that the differences of  $3.8 \pm 1.10\%$  for primigravidae and  $4.1\% \pm 1.33\%$  for the multiparæ achieved by the dietetic methods adopted in the work sponsored by the People's League of Health are probably of no significance. My conclusion is reinforced by their admitted failure to influence the birth-weight of the babies.

The 1942 histogram is interesting as showing a preponderance of allegedly premature infants. An explanation of this shift appears to be that London mothers are reluctant to go into the reception areas for their confinement and, to avoid doing so, deliberately misstate their expected date. By this means they contrive to be admitted to hospital in London at the onset of labour.

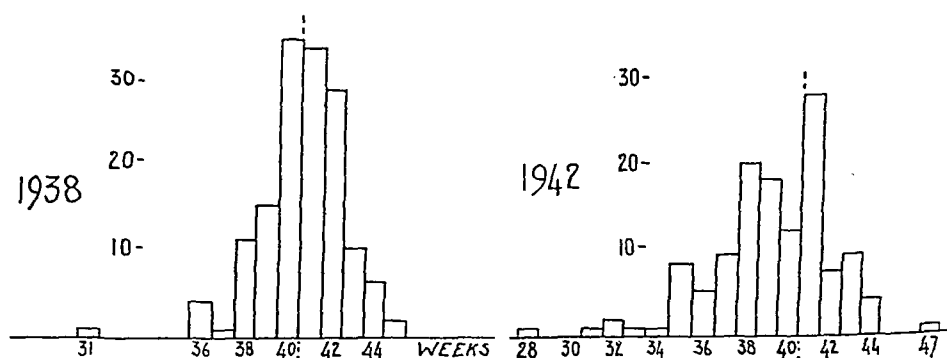


FIG. 1.

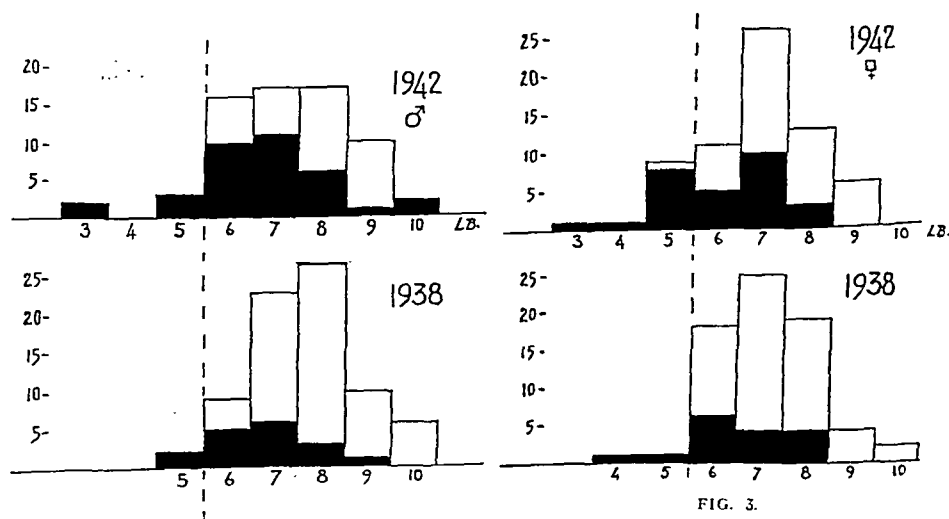


FIG. 2.

In figs. 2 and 3 the distribution of birth-weights is shown. The black areas refer to infants born allegedly before the 40th week. The suggestion of falsification of dates is borne out here, for it is clear that the proportion of infants of normal weight born allegedly before term is much greater in 1942 than in 1938.

Table III shows that in 1938 less than 10% of premature babies were immature, and in 1942 less than 24%. On the other hand, there is only one instance in each annual sample of an immature infant born after the beginning of the 40th week. One further point is demonstrated by this table, that the problem of immaturity may be one of immediate and topical interest. Four out of 147 infants proved to be immature in 1938, i.e. less than 3%, whereas 17 out of 135, or more than 12%, were immature in 1942. The difference is unlikely to be the result of chance.

TABLE III.

	Birth-weight	Calculated gestation period		Total
		Before 40th week	In and after 40th week	
1938	5½ lb. and over ...	29	114	143
	Under 5½ lb. ...	3	1	4
	Total	32	115	147
1942	5½ lb. and over ...	51	67	118
	Under 5½ lb. ...	16	1	17
	Total	67	68	135

## SUMMARY

(1) In spite of very loose certification of neonatal deaths, both as regards cause and as regards exact age, it is probable that immaturity plays a very important part in the deaths of infants in the early weeks of life.

(2) Though there is no reason for supposing that the problem of preventing immaturity has been solved, the proper treatment of immature infants can help to reduce neonatal mortality.

(3) Such treatment and the instruction of pupil midwives and medical students in its methods is essentially the job of the paediatrician, and the Ministry of Health should instruct local authorities to equip the evacuated midwifery services in their areas with a paediatric service.

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 EBBS, J. H., TISDALL, F. F., and SCOTT, W. A. (1941) *J. Nutr.*, 22, 515.  
 —, BROWN, A., TISDALL, F. F., MOYLE, W. J., and BELL, M. (1942) *Canad. med. Ass. J.*, 46, 8.

Professor James Young said that the investigations in Oslo, Toronto and London had drawn attention to the critical importance of maternal nutrition for the healthy development of the child both before and after birth. The Oslo and Toronto workers had shown that where the mother's diet was good there was a lowering of the abortion and prematurity rates. But the total figures on which these and other similar investigations were based were so small or the controls were so inadequate that it was doubtful if they were beyond statistical reproach. For this reason the recent Report of the People's League of Health was important. This was probably the most comprehensive and the best controlled investigation ever carried out on this subject. It was based upon observations on 5,000 antenatal women in 10 London hospitals. The women were divided into two equal groups by strictly alternate enrolment and they were, moreover, grouped by age and parity. 2,500 received additional supplements containing those materials (calcium, iron, iodine and vitamins A, B, C, D) in which the dietaries of a large proportion of the population were known at that time (1938-9) to be defective. The other group of 2,500 women acted as controls.

Two important results of statistical significance from the standpoint of the present discussion were revealed. In the first place the incidence of pregnancy toxæmia was about 30% less in the treated than in the control women. Toxæmia was known to be one of the chief factors in prematurity, stillbirth and neonatal death. In the second place the prematurity rate was about 17% less.

Whilst our aim must always be to ensure an adequate and balanced diet of fresh food to expectant mothers there was a risk, especially at a time when the need for food restriction was great and likely to increase, of the administrative arrangements concerned with the growth, import and disposal of our food materials being haphazard unless they were based upon a scientific knowledge of differential values. This was a matter of no small urgency at the present time. When the time arrived for the transport of large

quantities of food-stuffs to the Continent for the succour of the millions suffering privation and starvation, it would become a matter of supreme moment. It was obvious that expectant mothers would then become a very special responsibility. It would be necessary to ship immense quantities of food including vitamin concentrates to Europe after the war and to continue this until the first harvests became available. Meanwhile only by a concerted effort now to establish comparative values could we hope to ease the immense administrative problems which would then arise.

The influence of maternal nutrition on the health and life of the child had, in addition, an important bearing on the population problem facing this country and the Empire. This problem already recognized by competent authorities as serious before the war would become much more grave during and after the war by the withdrawal and loss of a large proportion of the male population. Therefore the feeding of mothers should receive special attention and by further research the newly acquired knowledge on the importance of maternal nutrition in the prevention of prematurity and stillbirth should be directed along effective lines.

Professor Young gave figures relating to changes in the infant birth-weights, the prematurity rate and the toxæmia rates since and during the war. This study had been carried out by Dr. Hargreaves at the British Postgraduate Medical School on "booked" cases during the years 1937 (1,597 cases), 1938 (1,765 cases), 1940 (954 cases), 1941 (846 cases) and 1942 (662 cases). The average birth-weights of full-time children had shown a decline since the pre-war years in primigravidae from 7.3 to 7.1 lb. and in multigravidae from 7.6 to 7.4 lb. The percentage prematurity rates had declined, though not so consistently, from 19.7 to 14.2 in primigravidae and from 16.7 to 13.6 in multigravidae. The percentage toxæmia rates had shown no consistent change. It was true that evacuation schemes had tended to a differential disturbance of the populations during the war years. Making allowance for these factors the figures seemed to indicate that in this group there had been an appreciable fall in the average birth-weight of the children and that the prematurity rate had declined. Similar studies in other areas would be valuable.

Professor Baird, in replying on the discussion, said that he would like to challenge Sir Francis Fremantle's observations on intelligence and environment. He preferred to wait to see the environment standardized before he passed any opinion on the other factors concerned.

He thought that Dr. Bell's criticism of the Toronto figures was quite justified. The figures were on a very small scale. Just before the war Sir John Orr had made arrangements for a similar investigation to be carried out in Aberdeen to synchronize with the investigation in Toronto, but the onset of war made the Aberdeen investigation impossible. He fully agreed that from groups of 90 or 110 cases it was impossible to draw conclusions, but the work should be repeated on a large scale as soon as possible.

Dr. Bell had spoken about the need for the appointment of a paediatrician to some of these emergency hospitals. That might be necessary, but it would be only a war-time measure. What he would like to see was more appointments of the type recently made at Newcastle, where Dr. Spence had been appointed Professor of Child Life, which was a very progressive step. The difficulty was to use the obstetricians and paediatricians to help the Medical Officers of Health and their staffs to organize the health services. Too often the senior members of the health services became administrators divorced from clinical work.

He had been interested in Professor Young's figures, which were very suggestive. He had found the incidence of pre-eclamptic toxæmia in primigravidae in Aberdeen in "booked" hospital cases to be about 8%. This was fairly near the London figures, which surprised him, because he had always understood that there was relatively little toxæmia in London. The incidence of toxæmia in the small series of private cases was only 3%. These facts were in keeping with Professor Young's view that diet influenced the incidence of toxæmia.

The incidence of prematurity, as defined by Professor Young, in hospital cases in Aberdeen amongst primigravidae was 24%, as compared with Professor Young's 23%. But in private practice on the same standard the prematurity rate was only 8%. The evidence is sufficiently strong to recommend the giving of vitamin and other preparations in tablet form to make up for deficiencies in the diet.

# Section for the Study of Disease in Children

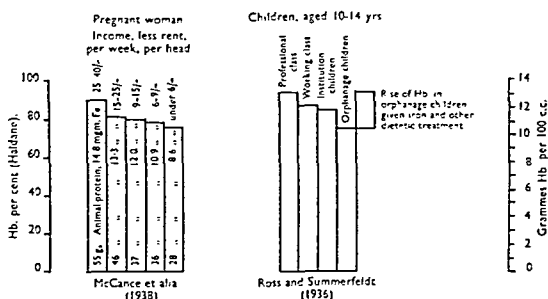
President—DONALD PATERSON, M.D.

[October 23, 1942]

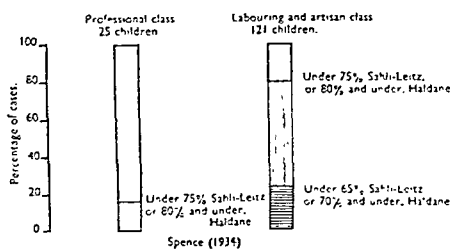
## DISCUSSION ON NUTRITIONAL ANÆMIA IN CHILDREN AND WOMEN: A WAR-TIME PROBLEM

Dr. Helen M. M. Mackay, Dr. Lucy Wills, Dr. R. H. Dobbs and Lady Bingham : It is a surprising fact that in spite of the intensive work on anæmia of the past ten to fifteen years, we still have no generally accepted standards of the limits of normal hæmoglobin levels in adults, let alone in children.

*Influence of economic status on mean hæmoglobin level.*—We know that the hæmoglobin level is affected by economic status and diet, and Graphs 1 and 2 show some examples



GRAPH 1.—Economic status and diet in relation to mean hæmoglobin levels



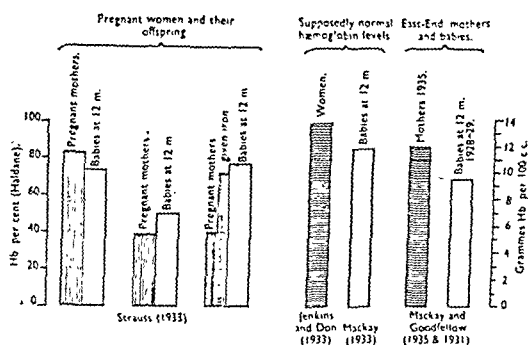
GRAPH 2.—Economic status and hæmoglobin level. Children aged 1-5 years in Newcastle-on-Tyne, in 1933.

of this. McCance and his colleagues (1938) found a steady fall in the hæmoglobin level of pregnant women grouped by income level, from an average of 90% for those with an income of 25/- to 40/- per head after payment of rent, to an average of 76% for those with under 6/-, a difference of 14% in hæmoglobin. The first group had an average daily intake in round figures of 15 mg. of iron and 55 g. of animal protein, and the last 9 mg. of iron and 28 g. of animal protein. Ross and Summerfeldt (1936) found a similar drop in the hæmoglobin level of school children, aged 10 to 14 years; the mean hæmoglobin value of their professional-class children was 94%, of their working-class children 87%, and of children in an orphanage 75% (converted to the Haldane scale). The hæmoglobin level of the children in the orphanage was raised by 20% by giving iron together with other dietetic treatment, hence their anæmia was nutritional in origin.

There are few figures available for the comparison of hæmoglobin levels of babies and young children of different economic class. Spence in Newcastle-on-Tyne (1934) (Graph 2)

examined in 1933 a small group of professional-class children, aged 1 to 5 years, and a larger group of working-class children, and found that only 16% of the former as against 80% of the latter had a hæmoglobin level below 75% on the Sahli-Leitz scale (or 81% on the Haldane scale).

Anæmia in babies is, I think, undoubtedly in part the result of anæmia in their mothers during pregnancy. Evidence of this is difficult to provide, but Strauss (1933) has given some cogent facts (Graph 3). The babies of a group of mothers with severe anæmia during



GRAPH 3.—Hæmoglobin levels in women and in babies at 12 months of age.

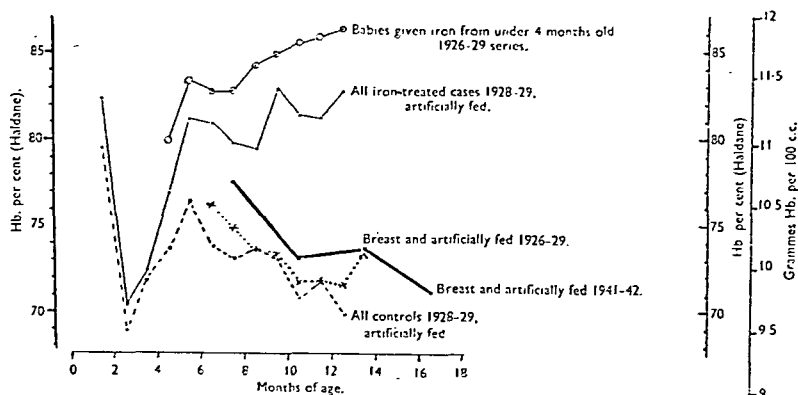
pregnancy (average hæmoglobin 39%) had at 12 months old an average value of only 50% (converted to the Haldane scale). Other severely anæmic mothers were treated by Strauss during pregnancy, and their mean hæmoglobin was raised from 40 to 72% before term. Their babies at 12 months old had a mean hæmoglobin level of 77%, a figure which is very similar to that of infants whose mothers' hæmoglobin was considered normal. The hæmoglobin level of non-pregnant East End mothers whom we examined eight years ago (Mackay, 1935) averaged 13% below the supposedly normal figure, hence the subnormal hæmoglobin of infants in the same district (Mackay, 1933) was presumably in part at least the result of nutritional anæmia in their mothers.

*Influence of moderate grades of anæmia on health.*—Does a drop of say 10 to 15% in the mean hæmoglobin level result in any deterioration in general well-being? In the case of infants it can be answered definitely in the affirmative. Babies from working-class families treated with iron had by 12 months old a mean hæmoglobin level 13% higher than controls (Graph 4, 1928-29 series), and weighed about one pound heavier (Mackay and Goodfellow, 1931). They had a morbidity rate about half that of controls. This difference in health is, I think, established beyond doubt. The work was repeated with a second series of children, and the reduction in morbidity rate was remarkably constant over a period of years (Graph 5). No similar evidence, so far as I know, is available for older children and adults, though the low resistance of severely anæmic patients is well known, and by analogy I would suppose that a drop of say 13% in the average value for adults would definitely reduce stamina. Certainly the difference in energy and well-being noted by the woman whose hæmoglobin is raised from 75% to 95% is striking.

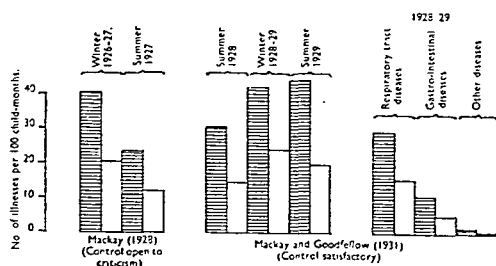
*Fallacies in hæmoglobin estimations from ear pricks in young children.*—There is one point which is sometimes forgotten. In infants and young children it is impossible to obtain reliable results from a prick in the lobe of the ear, and blood from the ear of a baby may give a result 30% and more higher than blood from the heel (Graph 6) (Drucker, 1923).

*Standards of comparison.*—Nearly all pre-war figures for average hæmoglobin levels for children in this country are based on examination of children of working-class families, and several of these series are shown in our graphs (Graphs 7 and 9). The only British investigators who have published average figures for all ages up to adult life are Davidson and his colleagues (1935). Davidson's subjects were examined during the period of economic depression in Aberdeen in 1931-35, and belonged to the poorest economic class. Davidson's mean figures for women were actually 11 to 19% lower than Jenkins and Don's (1933), for, as they put it, "representative women" in England, and the latter approximated to the mean for supposedly healthy women in other countries, as well as to Price-Jones' figure for nurses and women students at University College Hospital in 1931.

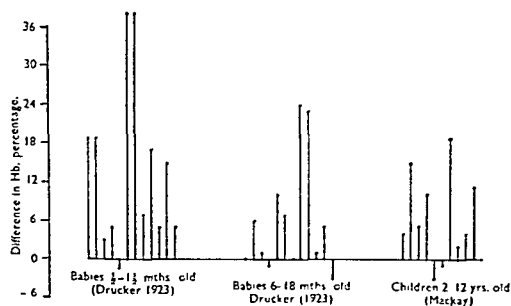
*Hæmoglobin levels of children examined in war-time.*—Since the autumn of 1941, we have estimated the hæmoglobin level of about 850 children and 550 women, that is



GRAPH 4.—The effect on the haemoglobin level of infants from working-class families of giving iron incorporated in dried milk. (Mackay and Goodfellow, 1931.)



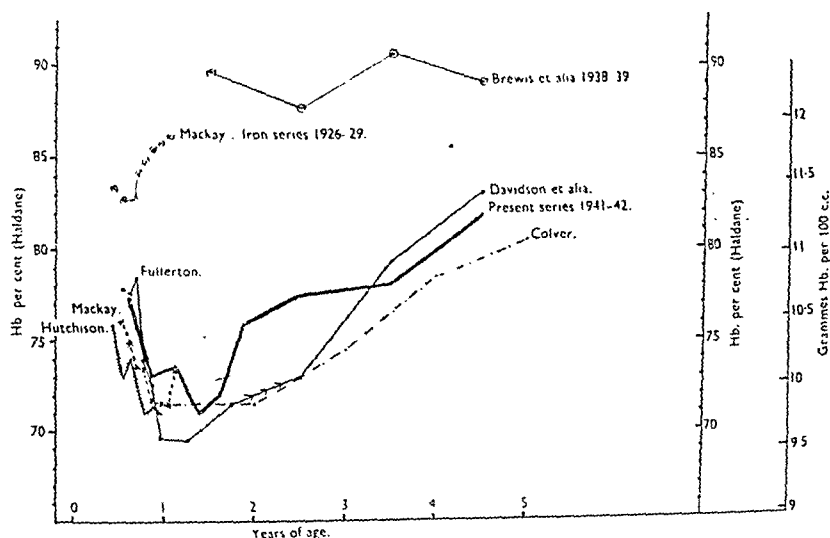
GRAPH 5.—Effect of anaemia on the morbidity rate of babies. Hatched columns: illnesses of controls. Plain columns: illnesses of babies given iron.



GRAPH 6.—Difference in haemoglobin estimations from heel and ear pricks. Two estimations on each child: each line represents excess of estimation from prick of ear (consecutive estimations).

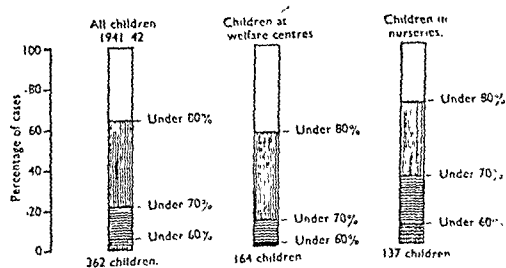
approximately 1,400 persons in all, though all the data are not yet analysed (Mackay, Wills, Dobbs and Bingham, 1942; Wills, Mackay, Bingham and Dobbs, 1942). The groups we examined supplied us with interesting information, but they did not represent a cross-section of the community. The children were nearly all working-class with some lower middle class. Graph 7 shows, for comparison with our present series of children aged 6 months to 5 years, the haemoglobin curves of various groups of working-class children who received no prophylactic treatment and who were examined by different investigators in different parts of Britain between 1926 and 1937 (Davidson *et al.*, 1935; Fullerton, 1937; Colver, 1938; Hutchison, 1938). All these curves show a remarkable measure of agreement, and our war-time curve corresponds closely with the rest. Thus the war-time babies under 12 months of age have mean haemoglobin levels similar to the control group shown in Graph 4, that is the group whose morbidity rate was double that of iron-treated babies. The series examined by Brewis, Davison and Miller in 1938-39 have a haemoglobin level

considerably higher than the rest. There are few figures available for the immediate pre-war years, but we know that at that time iron was widely given in welfare centres, and we believe that the incidence of anæmia had been much reduced in many areas, in which case our war-time figures indicate a retrogression.



GRAPH 7.—Haemoglobin levels in children under 5 years of age. British series: children of working-class families.

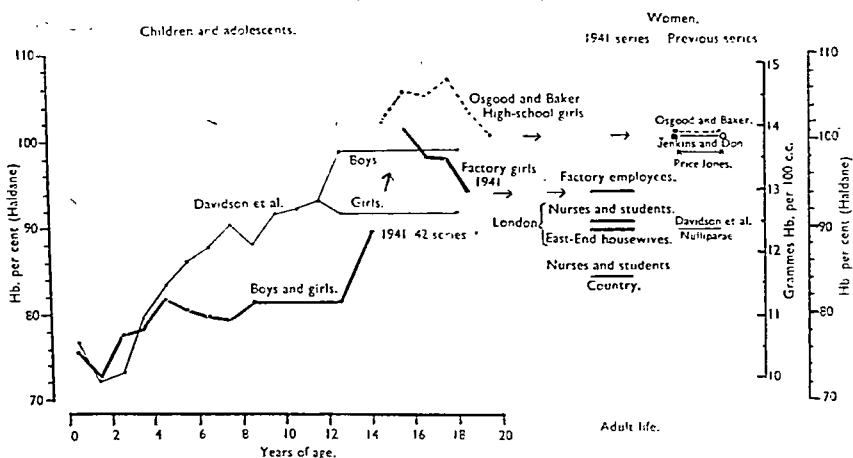
In our present series the incidence of severe anæmia was higher in the age-group 6 months to 2 years than at any subsequent age, and was much higher in the children we examined in day and residential nurseries than in those attending welfare centres (Graph 8), for



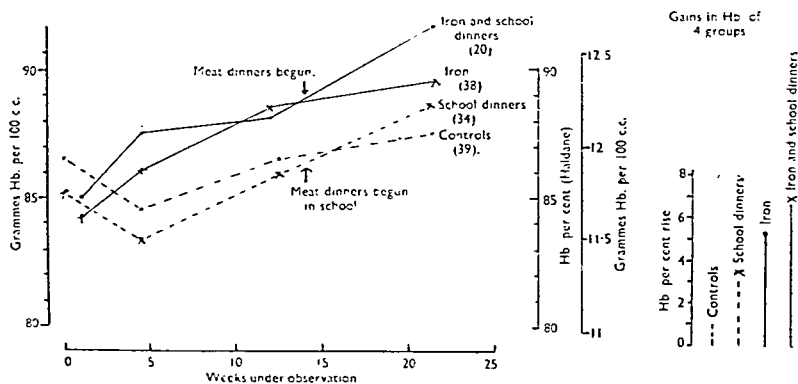
GRAPH 8.—Haemoglobin levels in children 1-5 years old in 1941-42. Children at welfare centres and in nurseries compared.

example among the welfare children 12% had less than 70% haemoglobin, and in the nursery group 34% were below this level, and 9½% of the children had less than 60% haemoglobin. If our figures are representative, they merit the serious consideration of those setting up war-time nurseries.

It is probable that in war-time, the mean haemoglobin level of school children varies from time to time and group to group according to the food available. Ninety school children aged 5 to 13 years whom we examined last winter had a mean haemoglobin level of 80%, which is about 10% lower than the poor Aberdeen children of a similar age in Davidson's series (Graph 9). A series we have since had under observation had a mean level of about 85%, and treatment with iron or the provision of school dinners each caused a significant rise in haemoglobin level, though the rate of improvement was slow (Graph 10). A small group receiving both iron and school dinners had a mean level of 92% at the end of last summer term, and possibly their haemoglobin level would have risen still higher had treatment been continued. We are now analysing data from school children of rather higher economic status in a London suburb, and here there does not appear to be a difference between the haemoglobin levels of children having school dinners and controls. They were examined in autumn. Possibly other speakers can tell us whether there is a seasonal rise in haemoglobin in the summer. There is a striking similarity between our war-time figures for mean haemoglobin levels of children in or near London and Davidson's war-



GRAPH 9.—Hæmoglobin levels from the age of six months to adult life.



GRAPH 10.—The effect of iron therapy and school dinners on the hæmoglobin level of a group of school children. Figures in brackets indicate total number of children at time of last estimation. The rise per cent in each group is shown on the right.

time figures for Edinburgh (*see below*). The chief difference is that our pre-school groups examined at welfare centres have somewhat higher hæmoglobin levels than his.

A small group of adolescent factory girls, living in their own homes and working in a small town, had a higher hæmoglobin level than any other group we examined last winter: this was the only group with a definitely higher hæmoglobin level than the British pre-war group with whom we compared them. They were 7% higher than the girls of the poorest economic stratum in Aberdeen a decade ago, but considerably lower than Osgood's (1935) series of American high-school girls. Their relatively good hæmoglobin level may perhaps have been due to their access to country and garden produce, but of this we have no proof.

**Hæmoglobin levels of women examined in war-time.**—The groups of adult women examined were professional and middle class, represented by women medical students and nurses, and also working-class, represented by employees (apparently comfortably off), of a factory in a small town, and housewives in the East End of London. These groups all had hæmoglobin levels significantly lower than the pre-war means of either Jenkins and Don for "representative women" in England, or Price-Jones for nurses and women medical students. The group with the highest hæmoglobin levels in our series was that of the factory workers with a mean value of 94%. Those with the lowest were medical students and nurses, working in the country and living either in billets or in hospital without adequate canteen facilities; their mean hæmoglobin was 84%. This figure for professional-class women was actually 5½% lower than Davidson's figure for nulliparae of the poor working-class in Aberdeen in 1931-35. Dr. Wills has evidence that the anaemia was nutritional in origin, and of this Dr. Dobbs will speak later. The small group of East End mothers had a mean hæmoglobin level very near that of a similar group in the same district eight years



ago, at a time when there was much poverty and unemployment, unemployment which has now vanished.

**Conclusions.**—It seems fair to conclude from the evidence available to us that in many classes of the community there has been a levelling down of hæmoglobin levels. This appears to be due to the levelling down of nutrition since the war, and the omission of most of the prophylactic treatment previously given to babies. As against this, the poorest section of the community may well show some levelling up, as the result of the disappearance of unemployment; the introduction of rationing and the provision of "priorities" for certain groups, but on this point we have no evidence. The levelling down in hæmoglobin values appears, however, to be operating widely, and extends to the county council school children in our series who belonged to working-class families, and probably to children of pre-school age of the same economic class. If the hæmoglobin level of pregnant women nowadays is lower than before the war, this is likely to be reflected in a greater tendency to nutritional anæmia in their offspring.

**Suggested prophylactic measures.**—What then do we suggest should be done to tackle this problem of anæmia in women and children in war-time? Every effort should be made by means of priority schemes and by communal meals in schools and canteens, or other centres, to ensure the best diet possible under war-time conditions for pregnant or nursing mothers and for growing children, particular attention being given to the iron content of the diet. The work of Le Gros Clark (1942) emphasizes the need of educating the public in the importance of a fair division of the family rations to ensure that the mother and young children get their full share of meat. However, it will probably prove impossible by such means alone, and with meat in short supply, to prevent anæmia, hence iron therapy and iron prophylaxis should be widely employed, though it should be remembered that iron deficiency is probably not the only factor operating. Efficient prophylactic measures for infants have already been demonstrated. They are the administration of iron, either in the form of a mixture or, better still, if the infant is artificially fed, incorporated in dried milk, not forgetting also the importance of weaning on to iron-rich foods, including minced meat, at about 6 months. We are pleased to read that the Department of Health in Scotland has just issued a pamphlet in which they advise that an iron mixture should be given to babies whether breast or bottle-fed. The value of bread fortified with iron is at present under investigation as a possible means of tackling anæmia at ages past infancy. If we are not afraid of adding cod-liver oil or calcium to make good specific deficiencies, let us not fail to use iron salts also where health can thereby be improved, while trying at the same time to use our food supplies to the best advantage. More investigation is also much needed. Our investigation covers only a few sample groups, and the incidence of anæmia may well vary widely. We hope others will give us facts and figures which will allow us to form a clearer picture of what is happening, and perhaps throw light on the particular dietetic defects implicated.

**POSTSCRIPT.**—The National Physical Laboratory has recently defined a standard for the Haldane colour tube on the trichromatic scale (specification 1079/1942). The N.P.L. has examined the Haldane standard used by the present authors in their investigations, and reports the carboxyhæmoglobin concentration of this standard to be 1.04%, taking the concentration of the new official standard on the trichromatic scale to be 1.000. In giving this figure the N.P.L. assume that the manufacturer has positioned the 20 and 100 marks correctly on the colour tube under test, but point out that this assumption may not be correct. However, assuming that there is no error in the positioning of the marks, all readings on the authors' standard require correction by +4.8 per cent. to bring them into line with the official standard, thus a reading of 50% made with the authors' hæmoglobinometer would be corrected to 52.4%. Whether or not this indicates any change in the colour of this tube during the past seven years is unknown. The tube was bought in 1935, and by a cross check was then found to tally with one of Price-Jones' standards of 1931. In 1941 it was checked by the oxygen capacity method and reported still correct within 1%. Moreover the correction factor given by the N.P.L. for the colour tube used by the present authors and for that used by Professor Davidson in Edinburgh are, we understand, almost identical, hence the hæmoglobin values for the London and Edinburgh investigations are comparable without further correction.—H. M. M. M.

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**Dr. Leonard Findlay:** *The blood as an index of health.*—As part of a survey of the development and health of the child I have, during the past decade, made systematic observations of the blood picture.

The observations have been carried out in children living under very different environmental conditions. Until the outbreak of war they were made on children of the East End of London. During the last eighteen months, however, the type of child observed has been that born and bred in the semi-rural conditions of a country town.

As a hospital physician, I have not had access to a true cross-section of the total child population in either of these communities, and my material consists of the hospitalized and thus presumably the sick members only. However, as a goodly proportion of the children admitted to hospital were either only suspected of illness or suffering from some slight ailment, and since it is only the minority who have had their constitutions undermined by serious or chronic disease, I believe that a study of such individuals will give some measure of the physical development and health of the total populations of which they form a part. It can at least be said that the material forms the basis for a true contrast, a contrast between the hospital child in the city and the hospital child in the country.

In 1937 I published the results of a survey of the blood picture in a series of patients admitted to the Princess Elizabeth of York Hospital for Children during the two previous years. This investigation did not reveal the presence of any marked incidence of anæmia for, excepting during the first three months of life, the vast majority of the estimations of both hæmoglobin and red blood corpuscles fell within the limits of normality as quoted by Hutchison (1909) and by Holt and McIntosh (1933). At the time of their publication these findings were criticized on the ground that the blood had been obtained from the ear and thus abnormally high and fallacious readings had been obtained. Since there is no doubt that higher readings are frequently obtained in blood got by ear puncture than by finger or heel puncture, but chiefly to render my findings comparable with those of other workers, I collected a further series of observations on the same type of child in the years immediately preceding the outbreak of war. In these cases the blood was obtained from puncture of the finger or heel. The hæmoglobin was as before estimated by Haldane's method, the standard being corrected periodically. All the blood examinations were carried out by one individual.

The results of this investigation also failed to reveal any serious incidence of anæmia. Again it was found that in the great majority of instances the values of both hæmoglobin and red cells fell above the lower limit of normality. Indeed, so far as the very young infants are concerned, there was even less suggestion of anæmia, for the proportion of low readings was distinctly less in this group than had been found in the first series of children.

For comparison with these findings in the case of the child of the East End of London, I have at the moment available complete observations on some 400 native children of Oxford and its environs, who have been admitted under my care to the Radcliffe Infirmary. For the blood examinations I am indebted to Dr. R. G. Macfarlane and his assistants, but it should be stated that in the majority of instances the estimations were carried out by the one individual. As in the previous series the blood was obtained from puncture of the finger or heel, the latter site being employed only in a few of the youngest infants, and the hæmoglobin was determined by Haldane's method, the standard again being corrected periodically.

The most striking feature of the Oxford findings was the proportion of the estimations of both hæmoglobin and red cells which fell below the minimum level of normality. This is in striking contrast to what was found a few years previously in the children of the East End of London, where the hæmoglobin and red cell values were in 70 to 100% of instances within normal limits for the various age-periods specified. In the Oxford

children only 34 to 73% of the hæmoglobin estimations were within normal limits, and in the case of the red cell estimations the percentage which fell within the limits of normality varied between 36 and 58 for the same age-periods.

This finding, an apparently better state of health of the children in the East End of London than that of the child who is a native of Oxford and its environs, that is if the hæmoglobin and red cell values can be taken as an index, was most unexpected. One might at first think that the notorious differences between individual Haldane standards was responsible for these varied findings, but the parallel behaviour of the red cell count would seem to eliminate this source of error. It is possible of course that the health of the child population generally has deteriorated since the war, and that the East End children, if examined to-day, would not be so satisfactory. The examination of children evacuated from London to Oxford, and admitted to the Radcliffe Infirmary, did not, however, lend any support to such a hypothesis. In them the proportion of hæmoglobin and red cell estimations below the level of normality was distinctly less than in the children who were natives of Oxford. Such a possibility, too, is also rendered unlikely by the findings in recently published reports by school medical officers throughout the country which reveal a continuation since the war of the progressive increase in the average height and weight for age of all children which has been apparent now for many years. And when we consider the development of the Oxford children, as indicated by their height for age, there is certainly no evidence of deterioration: indeed, in this respect, they are definitely superior to children of the same social class in other parts of the country.

In Charts 1 and 2 are plotted the heights of the Oxford Hospital group of children for different ages against the standard average of Holt, the average which I found for the child of the wealthier classes in the West of Scotland between 1920 and 1930, the average as found by Noël Paton and myself in the child of the labouring class in Glasgow during the same period, and finally, the average as found in the case of the Glasgow school child during the year 1941. These charts show that the Oxford child compares favourably with the better class child in the West of Scotland and is superior to the child of the same social class in other parts of the country. 70% of the boys' heights, and 60% of the girls' heights, are above the standard average as given by Holt, and practically all are above the average of the child of the labouring classes in Glasgow and that of the Glasgow school child for 1941.

It is difficult, in the face of these findings, to relate the lower hæmoglobin and red cell values found in the Oxford group of children to some nutritional defect, since I know of no more marked difference between different classes of society, and thus presumably between the results of diets of varying excellence, than in the average height for age. If the lower hæmoglobin and red cell values in the Oxford children are to be ascribed to a faulty diet, then it must be of such a nature that, while it produces anæmia, growth is promoted. This means, I assume, a diet which is ample in its supply of the essential proximate principles and vitamins but deficient in iron. Now, since it is just those foods that are rich in the essential proximate principles which provide the most abundant supply of iron, such a particular fault would seem unlikely. Nevertheless, the opinion is fairly generally held that the low hæmoglobin values recorded so frequently to-day in members of the less favoured classes of society, particularly among the women and children, are due to just such a dietary error.

To exclude the possibility of such a dietary defect I have administered additional iron in ample amounts over prolonged periods, not only to the anæmic but also to the apparently normal child. As the daily requirements of iron vary from a few milligrams in the young infant to at most 15 mg. in the adult, the dosage I employed was sufficient for this purpose. In the infants this varied between 20 and 60 mg. per day and in the older child between 120 and 400 mg. per day.

I have found it impossible to influence the fall in the hæmoglobin content and red cell count during the early months of infancy, nor did I find that the rise in these values during later infancy was any more satisfactory in those infants who had been receiving iron from soon after birth in doses varying between 20 and 60 mg. per day than in those babies who did not receive additional iron. Charts 3 and 4 show my findings in two small groups of infants studied in London and Oxford, and they reveal no noticeable effect of the treatment in either of the two groups. In the case of the older child with a normal hæmoglobin value, i.e. between 70 and 80% by Haldane's standard, there occurred little change in its level during the continuous administration of iron in doses varying between 120 and 400 mg. per day, over a period of months which extended in some cases to as much as one year. In some of the children there was absolutely no variation in

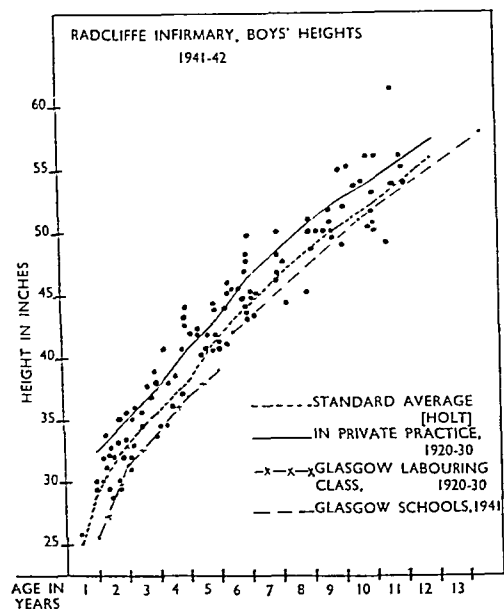


CHART 1.

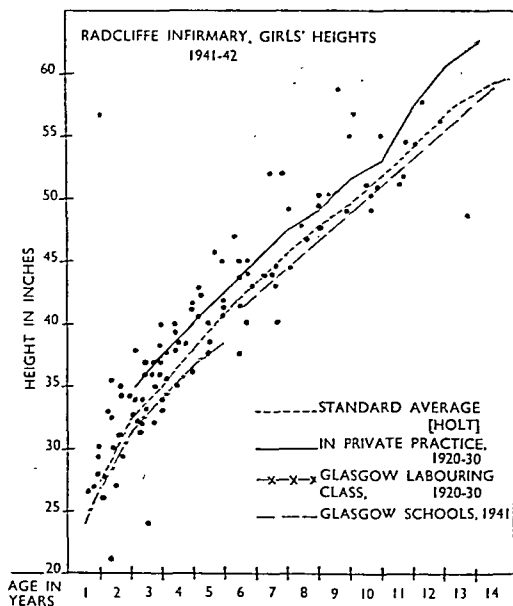


CHART 2.

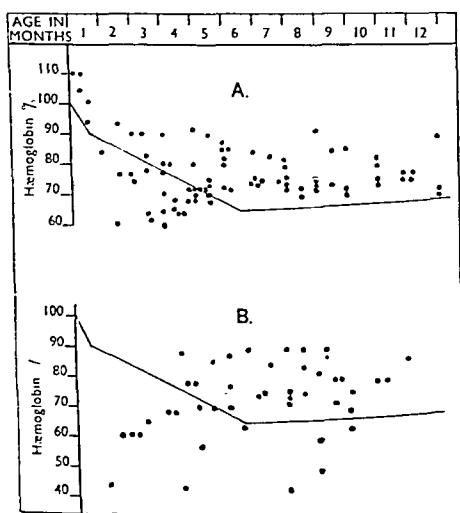


CHART 3.—Composite chart of hæmoglobin percentage in infants (A) without iron therapy and (B) receiving iron in the form of ferri et amm. cit. Princess Elizabeth of York Hospital for Children, 1936-1939. Continuous line indicates lower level of normality.

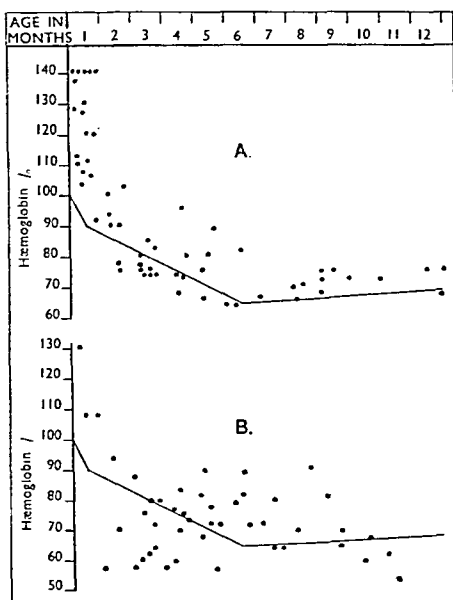


CHART 4.—Composite chart of hæmoglobin percentage in infants (A) without iron therapy and (B) receiving iron in the form of ferrous sulphate. Radcliffe Infirmary, Oxford, 1941-1942. Continuous line indicates lower level of normality.

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presumably the optimum. If this were the case, the higher level would surely be maintained. The optimum level of the hæmoglobin and number of red cells would seem to vary with the individual, and to be dependent on factors other than the iron content of the diet. The slight initial and evanescent rise in the hæmoglobin seen occasionally in the normal individual is more probably to be explained by the iron exerting a stimulating or irritating effect but to which the hæmatopoietic system soon becomes accustomed. And in the cases of anæmia the recovery would not seem to be due solely to the supply of the essential constituent of the hæmoglobin, but is also presumably in part the result of the stimulating action of the iron causing a temporary hyper-hæmatopoiesis. Were it otherwise one would not expect the invariable fall which is seen to occur after the initial rise. In anæmia, however, as is understandable, the reaction to the stimulating effect of the drug is more marked and of longer duration than in the non-anæmic individual.

An investigation which I carried out on the blood in rickets (1909) may provide an explanation of these variations in the blood. During this study I found that the rachitic child reared in a Glasgow slum tended to have a higher hæmoglobin level and red cell count than the absolutely healthy and non-rachitic child of the better classes fed and housed in more salubrious regions on the outskirts of the City. As the rachitic child is seldom taken out of doors I was inclined to ascribe the higher blood values which he presented to the fact that he had been spending most of his time in a congested and unhygienic environment. It was in short because he had been living in a rarefied atmosphere that a greater number of oxygen carriers, and a greater amount of the oxygen-carrying hæmoglobin, had been called for. We know that this happens under similar circumstances during intra-uterine life and when an individual lives at a great altitude above sea level, or again it may occur when there is some interference with the volume of arterial blood flow. Indeed, these are factors which have such a profound influence on the blood picture that they cannot be lost sight of in any discussion of this question. Thus may it not be that the causes of the variations in the blood estimations in the various groups of children which I have studied lie in a varying environment rather than in a varying diet? The lower values of the children resident in Oxford than in the children of the East End of London would thus be related to more salubrious surroundings, more fresh air and consequently more available oxygen. And the specially high values of both groups of children (rachitic and non-rachitic) found in Glasgow some thirty-five years ago would be explained by the very unsatisfactory conditions which prevailed in a large industrial community at that time. In those days a pall of smoke constantly overhung the city, there was much congestion of the population, almost half of which lived in one-apartment badly ventilated houses. And it cannot be too forcibly emphasized that the above environmental factors and also some metabolic abnormalities, which induce a high hæmoglobin value, are not productive of good health, so that it is fallacious to consider the level of the hæmoglobin and red cell content of the blood *per se* as an index of health.

#### CONCLUSIONS

- (1) The blood picture is not a true reflection of the state of health of the child. A well-developed child has often lower hæmoglobin and red cell values than a less well-developed child.
- (2) The blood picture is not necessarily an index of the iron content of the diet.
- (3) Iron administered considerably in excess of the body's requirements causes as a rule no change in the hæmoglobin level of the normal child. Occasionally there may ensue immediately after its presentation a very slight, but only transient, rise in the hæmoglobin level.
- (4) Iron administered in medicinal doses to examples of hypochromic anæmia causes a marked rise in the level of hæmoglobin. The maximum rise, however, is not sustained but falls after some weeks to a more moderate and normal level, although the same or even a larger intake of the drug is continued.
- (5) Iron in medicinal doses would thus seem to exert a stimulating or irritant effect on the hæmatopoietic tissues as well as supplying material essential for hæmoglobin formation. Otherwise, the highest level produced would be maintained. This stimulating effect is more marked in the abnormal than in the normal state.
- (6) The maximum level to which the hæmoglobin can be raised by the administration of iron cannot be considered the optimum or physiological level, since the highest values induced are not maintained.
- (7) The individual optimum level of hæmoglobin varies with age and sex. This would seem to be lower in infants than in older children, in children than in adults, and in females than in males.
- (8) The individual optimum level of hæmoglobin is also affected by factors which influence the oxygen supply or needs of the tissues, e.g. (a) environment, (b) defects in the cardiovascular system, and (c) abnormalities of metabolism.
- (9) The term nutritional anæmia would seem to be too loosely employed. It is unjustifiable to speak of a low hæmoglobin level as presumably arising from a dietary error. Many factors determine the hæmoglobin level of an individual, all of which must be considered before the true cause can be assigned.

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the hæmoglobin level, but in others, and especially in those who were receiving the largest amounts, there was a slight but only very temporary rise (Chart 5).

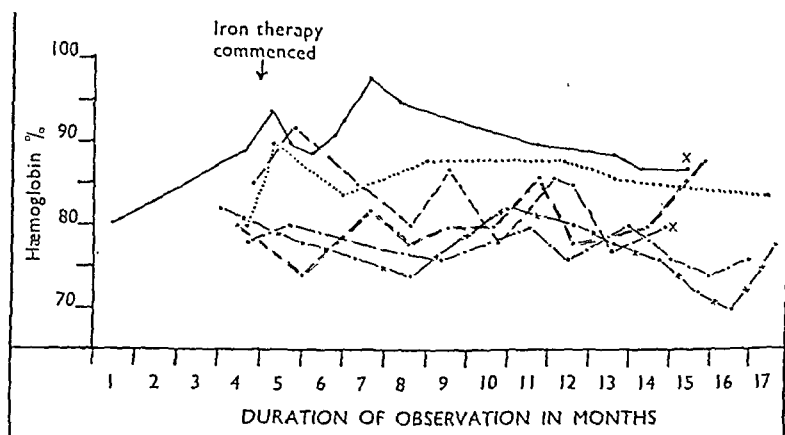


CHART 5.—Six normal children treated with continuous iron as ferrous sulphate (in 4 cases 120 mg. Fe per day; in 2 cases, marked X, 400 mg. Fe per day).

The course of events following the administration of iron was quite otherwise in the case of hypochromic anæmia (see Chart 6). In these circumstances there is usually, on

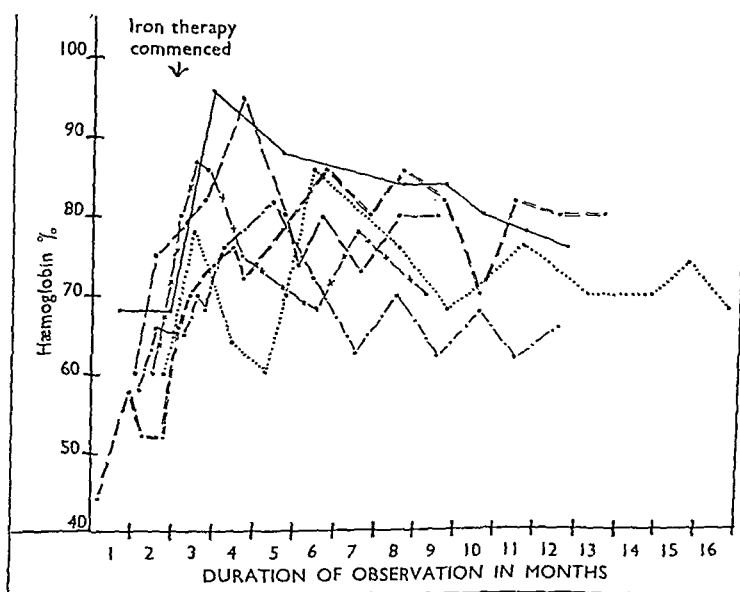


CHART 6.—Six examples of anæmia treated over long periods with iron as ferrous sulphate (dosage 120 to 180 mg. Fe per day).

the presentation of the drug, a rapid and satisfactory rise from a hæmoglobin level of 50 to 60% to one of 90% or higher during the course of a few weeks. I found, however, as has been pointed out recently by Fowler and Barer (1941), that the maximum level reached within a few weeks was not sustained but that after a time it fell to a varying and more moderate level at which it remained even although the same dosage was continued. Hence it would seem unjustifiable to conclude, as some workers have done, that the highest level to which the hæmoglobin can be raised by artificial means is

presumably the optimum. If this were the case, the higher level would surely be maintained. The optimum level of the hæmoglobin and number of red cells would seem to vary with the individual, and to be dependent on factors other than the iron content of the diet. The slight initial and evanescent rise in the hæmoglobin seen occasionally in the normal individual is more probably to be explained by the iron exerting a stimulating or irritating effect but to which the hæmatopoietic system soon becomes accustomed. And in the cases of anæmia the recovery would not seem to be due solely to the supply of the essential constituent of the hæmoglobin, but is also presumably in part the result of the stimulating action of the iron causing a temporary hyper-hæmatopoiesis. Were it otherwise one would not expect the invariable fall which is seen to occur after the initial rise. In anæmia, however, as is understandable, the reaction to the stimulating effect of the drug is more marked and of longer duration than in the non-anæmic individual.

An investigation which I carried out on the blood in rickets (1909) may provide an explanation of these variations in the blood. During this study I found that the rachitic child reared in a Glasgow slum tended to have a higher hæmoglobin level and red cell count than the absolutely healthy and non-rachitic child of the better classes fed and housed in more salubrious regions on the outskirts of the City. As the rachitic child is seldom taken out of doors I was inclined to ascribe the higher blood values which he presented to the fact that he had been spending most of his time in a congested and unhygienic environment. It was in short because he had been living in a rarefied atmosphere that a greater number of oxygen carriers, and a greater amount of the oxygen-carrying hæmoglobin, had been called for. We know that this happens under similar circumstances during intra-uterine life and when an individual lives at a great altitude above sea level, or again it may occur when there is some interference with the volume of arterial blood flow. Indeed, these are factors which have such a profound influence on the blood picture that they cannot be lost sight of in any discussion of this question. Thus may it not be that the causes of the variations in the blood estimations in the various groups of children which I have studied lie in a varying environment rather than in a varying diet? The lower values of the children resident in Oxford than in the children of the East End of London would thus be related to more salubrious surroundings, more fresh air and consequently more available oxygen. And the specially high values of both groups of children (rachitic and non-rachitic) found in Glasgow some thirty-five years ago would be explained by the very unsatisfactory conditions which prevailed in a large industrial community at that time. In those days a pall of smoke constantly overhanging the city, there was much congestion of the population, almost half of which lived in one-apartment badly ventilated houses. And it cannot be too forcibly emphasized that the above environmental factors and also some metabolic abnormalities, which induce a high hæmoglobin value, are not productive of good health, so that it is fallacious to consider the level of the hæmoglobin and red cell content of the blood *per se* as an index of health.

#### CONCLUSIONS

- (1) The blood picture is not a true reflection of the state of health of the child. A well-developed child has often lower hæmoglobin and red cell values than a less well-developed child.
- (2) The blood picture is not necessarily an index of the iron content of the diet.
- (3) Iron administered considerably in excess of the body's requirements causes at a rule no change in the hæmoglobin level of the normal child. Occasionally there may ensue immediately after its presentation a very slight, but only transient, rise in the hæmoglobin level.
- (4) Iron administered in medicinal doses to examples of hypochromic anæmia causes a marked rise in the level of hæmoglobin. The maximum rise, however, is not sustained but falls after some weeks to a more moderate and normal level, although the same or even a larger intake of the drug is continued.
- (5) Iron in medicinal doses would thus seem to exert a stimulating or irritant effect on the hæmatopoietic tissues as well as supplying material essential for hæmoglobin formation. Otherwise, the highest level produced would be maintained. This stimulating effect is more marked in the abnormal than in the normal state.
- (6) The maximum level to which the hæmoglobin can be raised by the administration of iron cannot be considered the optimum or physiological level, since the highest values induced are not maintained.
- (7) The individual optimum level of hæmoglobin varies with age and sex. This would seem to be lower in infants than in older children, in children than in adults, and in females than in males.
- (8) The individual optimum level of hæmoglobin is also affected by factors which influence the oxygen supply or needs of the tissues, e.g. (a) environment, (b) defects in the cardiovascular system, and (c) abnormalities of metabolism.
- (9) The term nutritional anæmia would seem to be too loosely employed. It is unjustifiable to speak of a low hæmoglobin level as presumably arising from a dietary error. Many factors determine the hæmoglobin level of an individual, all of which must be considered before the true cause can be assigned.

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Dr. H. M. Sinclair: *Nutritional anæmia and war-time diets*.—Dr. Helen Mackay has shown that hæmoglobin values are in general lower than before the war, and this she mainly attributes to a dietary deficiency of iron; the women living in the country fared worse than those in London. Professor Findlay, working in the "semi-rural city" of Oxford on native and evacuated children, has concluded that the blood picture is an index neither of the state of health nor necessarily of the amount of iron in the diet.

The Oxford Nutrition Survey has been collecting dietary, biochemical and clinical data on subjects in Oxford and elsewhere in order to assess the nutriture of samples of the population and relate it to the food consumed. Few results are yet available, but our hæmoglobin values are similar to those found in other current surveys; we have used the Haldane method upon venous blood from adults and blood from the lobe of the ear in children, and our standards have been checked by Dr. R. G. Macfarlane against the N.P.L. standard ("100%" is equivalent to 49.7 mg. Fe in 100 ml. blood). The following values have been obtained upon a random sample of certain areas in Oxford, upon students, and upon women attending an antenatal clinic and examined in the last month of pregnancy (Table I).

TABLE I.—HÆMOGLOBIN VALUES (%). Oxford Survey.

Sample	No.	Extreme values	Mean values	% of cases with Hb. value below	
				80%	70%
Boys (over 5 and under 15 years)	129	66—118	96	7	1
Girls (over 5 and under 15 years)	90	65—121	93	9	1
Students (men)	50	80—127	99	0	0
Students (women)	54	81—125	96	0	0
Men (over 15 years)	60	72—128	98	5	0
Women (15 to 45 years)	116	55—122	91	10	8
Women (pregnant)	108	57—105	85	31	10

Hæmatocrit values have been obtained by the Wintrobe technique upon these adults (Table II).

TABLE II.—HÆMATOCRIT VALUES (%). Oxford Survey.

Sample	No.	Extreme values	Mean value
Students (men)	91	36—51	45
Students (women)	42	35—46.5	40
Men (over 15 years)	48	33—51	44
Women (15 to 45 years)	51	32—47.5	40.5
Women (pregnant)	130	25.5—43	35.5

In mobile nutrition surveys conducted from Oxford, Dr. Meiklejohn has examined families with an infant under 2 years of age, and has obtained the figures shown in Table III. It will be seen that there is severe anæmia in some of the mothers.

TABLE III.—HÆMOGLOBIN VALUES (%). Mobile Survey (Dr. Meiklejohn).

Place	Date	Sample	No.	Extreme values	Mean value	% of cases with Hb. value below		
						80%	70%	50%
Accrington	Jan.—	Men	27	88—120	100	0	0	0
	Feb., 1942	Mothers	56	54—110	83	27	11	0
Merthyr-Tydfil	June—	Men	23	84—112	91	0	0	0
	July, 1942	Mothers	55	36—99	71	40	19	5

The increase in anæmia at the present time might be due to one of at least three dietary deficiencies: available iron, vitamin C, or protein. The main dietary differences that have been caused by rationing are a greater consumption of carbohydrate (particularly bread and potato) and of vegetables, and a smaller consumption of meat, fish, eggs, fruit and milk. In very general terms, a diet containing 12 mg. total iron *per diem* derives it now from the following sources: bread, potato, and rationed meat (2 mg. from each); unrationed meat, vegetables and other cereals (1 mg. from each); "Points" meat and offals (1 mg.); milk, eggs, fish and cheese (1 mg.); flour (0.5 mg.); other foods (0.5 mg.). Almost all the iron in potatoes is available, but only  $\frac{1}{10}$  to  $\frac{1}{4}$  of that in meat. As regards bread, the work of Widdowson and McCance (1942) has brought out some very interesting points: although brown bread contains two and a half times the amount of iron found in white, the former is a poor source of iron because very little is absorbed owing to phytic acid in brown bread making the iron unabsorbable; therefore the adoption of national wheat-meal bread has increased the liability to iron-deficiency anæmia. Despite the increased consumption of potatoes and vegetables, this alteration in the bread together with the diminished consumption of meat, fish, eggs and fruit probably means that diets now contain less available iron than they did before the war.

Of the other two dietary factors, there is no doubt that the intake of vitamin C is much lower now than before the war, since the increased consumption of potatoes and vegetables

is certainly not sufficient to redeem the shortage of fruit; and very low values for vitamin C in plasma are now found. To a less extent the same obtains with protein, particularly with animal protein, and low values for plasma protein are frequently found. There is, however, no evidence that deficiency of protein is an important cause of anæmia at the present time, except possibly in the macrocytic anæmia of pregnancy, mild cases of which have been attributed to this cause by Bethel.

The therapeutic response to iron obtained by Dr. Helen Mackay and others suggests that deficiency of this is the main factor involved; but Professor Findlay, like Fowler and Barer (1941), has cast doubt upon this interpretation. A preliminary analysis of dietary and biochemical results on 22 families examined by the Oxford Nutrition Survey in the summer of 1941 and again in the spring of 1942 indicates that the iron and vitamin C intakes increased considerably while the protein intake remained constant; the hæmoglobin values fell slightly, the plasma protein values did not change, and the plasma and white-cell vitamin C values remained very low. The increase in the dietary iron is probably largely due to the introduction of national wheatmeal flour in the interval between the two examinations, and as this is in fact a poor source of dietary iron the possibility remains that the slight fall in hæmoglobin values may be due to iron deficiency.

If we admit that during the war and particularly in women and children anæmia has increased, is increasing and ought to be diminished, it is reasonable to discuss the possible methods of doing this. The first simple way in which iron deficiency may be overcome is by the use of iron instead of aluminium cooking pots. A potato boiled for twenty minutes in an iron vessel contains about twice as much iron (about 3 mg. in a helping) as one cooked in an aluminium vessel; the difference with apples boiled for only five minutes is even more striking, since a helping from an aluminium vessel contains only 0.2 mg. but from an iron vessel nearly 100 times as much. The second obvious possibility is ferrated bread, and for this there is a precedent in the enriched bread of the U.S.A.; and iron salts, like calcium salts, could be added to overcome the larger amount of phytic acid that is found in brown bread. There are two possible objections: first, the prejudice against tampering with the "staff of life"—the gibe of fer:concrete will appear in uninformed circles; secondly, the possibility of producing toxic effects by an excess of iron. This latter point does not arise for two reasons. In Kaschin-Beck's disease enormous amounts of iron are ingested, but the only toxic manifestations were shown by Hiyeda to be due to "iron rickets", since excessive dietary iron tends to diminish the absorption of phosphorus. The second reason is that the recent work of Whipple (Balfour *et al.*, 1942) has shown that iron is only absorbed from the gut when the body stores are low, and that the body protects itself against excess.

Scant attention is paid to iron deficiency because the symptoms are slight and vague. If such slight deficiency is widespread amongst women and children immediate steps should be taken to remedy it, and the enrichment of bread with iron salts is the obvious war-time solution.

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Dr. R. H. Dobbs: *Anæmia in young women*.—In the absence of Dr. Lucy Wills, there are two aspects of the present discussion to which I would like to refer. In the first place, regarding the nature of the anæmia that is prevalent amongst young women, hæmoglobin estimations were made on two similar groups of nurses and medical students. One group were students and nurses at a teaching hospital in London, and the other the students and nurses at the hospital's E.M.S. base hospital in the country, where they had been for two months or more. The mean Hb. value of the town group was 90.6% and of the country group 84.1% (Mackay, Wills, Dobbs and Bingham, *Lancet*, 1942 (ii), 32). The living conditions and the diets of the two groups were investigated and it was concluded that there was little material difference in the conditions of life in the two hospitals, but that there were certain striking differences in the diets of the two groups. Table I shows the mean hæmoglobin level, the total daily Calorie, total protein and animal protein and daily iron intake of the two groups. It will be seen that in the country group, in which the mean Hb. level is lower, there is a smaller total and animal protein intake than in the London group. Moreover, the daily iron intake, though low in both groups, is not significantly different. In addition, the total daily Calorie intake is low in both groups and lower in the country than in the town group.

**Dr. H. M. Sinclair: Nutritional anæmia and war-time diets.**—Dr. Helen Mackay has shown that hæmoglobin values are in general lower than before the war, and this she mainly attributes to a dietary deficiency of iron; the women living in the country fared worse than those in London. Professor Findlay, working in the "semi-rural city" of Oxford on native and evacuated children, has concluded that the blood picture is an index neither of the state of health nor necessarily of the amount of iron in the diet.

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Women (pregnant)	108	57—105	85	31	10

Hæmatocrit values have been obtained by the Wintrobe technique upon these adults (Table II).

TABLE II.—HÆMATOCRIT VALUES (%). Oxford Survey.

	No.	Extreme values	Mean value
Students (men)	91	36—51	45
Students (women)	42	35—46.5	40
Men (over 15 years)	48	33—51	44
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The increase in anæmia at the present time might be due to one of at least three dietary deficiencies: available iron, vitamin C, or protein. The main dietary differences that have been caused by rationing are a greater consumption of carbohydrate (particularly bread and potato) and of vegetables, and a smaller consumption of meat, fish, eggs, fruit and milk. In very general terms, a diet containing 12 mg. total iron *per diem* derives it now from the following sources: bread, potato, and rationed meat (2 mg. from each); unrationed meat, vegetables and other cereals (1 mg. from each); "Points" meat and offals (1 mg.); milk, eggs, fish and cheese (1 mg.); flour (0.5 mg.); other foods (0.5 mg.). Almost all the iron in potatoes is available, but only  $\frac{1}{10}$  to  $\frac{1}{4}$  of that in meat. As regards bread, the work of Widdowson and McCance (1942) has brought out some very interesting points: although brown bread contains two and a half times the amount of iron found in white, the former is a poor source of iron because very little is absorbed owing to phytic acid in brown bread making the iron unabsorbable; therefore the adoption of national wheat-meal bread has increased the liability to iron-deficiency anæmia. Despite the increased consumption of potatoes and vegetables, this alteration in the bread together with the diminished consumption of meat, fish, eggs and fruit probably means that diets now contain less available iron than they did before the war.

Of the other two dietary factors, there is no doubt that the intake of vitamin C is much lower now than before the war, since the increased consumption of potatoes and vegetables

Professor L. S. P. Davidson: *Nutritional iron deficiency anaemia in war-time.*—Nutritional deficiencies in a population can be assessed in various ways; the estimation of iron deficiency being one method. The advantage of this method is that iron deficiency can be accurately determined by estimation of hæmoglobin concentrations. If such an investigation is made on representative samples of the population in war-time, the results can then be compared with similar figures obtained in peace-time and in this way the effect of war conditions on national health can be demonstrated. Such an investigation is at present being carried out in Edinburgh on infants, school children, and women of childbearing age, both pregnant and non-pregnant. The survey covers a representative cross-section of Edinburgh working-class population within these groups.

*Method.*—The Haldane hæmoglobinometer (13.8 g./100 c.c. equalling 100%) was used throughout the investigation. All apparatus used was checked against a standard set.

This paper will deal only with infants and school children; a second communication will be devoted to the hæmoglobin levels in women.

*Infants and preschool children (Birth-4 years).*—This group comprised 442 individuals; 318 being from birth to 23 months, and 124 from 2 to 4 years. None of them had received any iron therapy. A few children who were all between the ages of 9 months and 4 years had been given 25 mg. of vitamin C daily. Table I shows the grades of anaemia in infants (2 to 23 months) examined in Edinburgh, 1942, and in Aberdeen, 1935 (Davidson and Fullerton).

TABLE I.

Place	Age	No. of cases	Percentage of children in different Hb. ranges			
			Hb. <61%	Hb. 61-70%	Hb. 71-80%	Hb. >80%
Edinburgh	2-23 m.	262	5	23	42	30
Edinburgh	2-8 m.	143	4	15	40	41
Edinburgh	9-23 m.	119	5	33	45	17
Aberdeen	9-23 m.	298	15	23	49	13

It will be noted that the incidence of severe anaemia (less than 61% hæmoglobin) in infants of 9-23 months in the 1935 Aberdeen series is three times as great as in the 1942 Edinburgh series, but the percentage of moderately anaemic infants (61-70% hæmoglobin) has risen by 10% in Edinburgh as compared with the Aberdeen figure. It will be noted that 83% of the Edinburgh infants and 87% of the Aberdeen infants between 9 and 23 months have a hæmoglobin level of less than 80%.

*Children of preschool age (2-5 years).*—A comparison of the hæmoglobin levels of preschool children in Edinburgh in 1942 and in Aberdeen in 1935 showed that any advantage which the Edinburgh series had over the Aberdeen series in infancy was lost during the preschool period. Thus on entering school at 5 years the Edinburgh children had an average hæmoglobin of 81% compared with an average figure of 87% for the Aberdeen series.

*School children (5-12 years).*—The series examined in Edinburgh in 1942 consisted of 389 children attending two primary schools and 134 children attending a secondary, fee-paying school. The average hæmoglobin level for each of the classes was approximately 80%, and of these children 53% had less than 81% hæmoglobin. Table II shows the grades of anaemia in 389 Edinburgh primary school children, while Table III (see p. 16) shows a comparison of the hæmoglobin levels in school children in Edinburgh, 1942, London, 1942, and Aberdeen, 1935. In Edinburgh, 1942, and London, 1942, the hæmoglobin level throughout this age-period is considerably lower than in Aberdeen, 1935, the average difference for all ages being approximately 10%. In spite of this the children did not show obvious signs of malnutrition and in fact the anaemia would not have been revealed unless hæmoglobin estimations had been carried out. This increase in the incidence of anaemia is all the more striking when it is realized that the family income of the Edinburgh group, 1942, was on the average at least twice as large as in the Aberdeen group, 1935.

TABLE II.—GRADES OF ANÆMIA IN 389 EDINBURGH SCHOOL CHILDREN (5-12 years).

	No. of cases	Percentage of children in different hæmoglobin ranges			
		Hb. 60-70%	Hb. 71-80%	Hb. 81-90%	Hb. >90%
School I	197	9	46	36	9
School II	192	7	44	44	5
Combined	389	8	45	40	7

TABLE I.

	Mean Hb. level	...	...	London group	Country group
				90.6%	84.1%
				(12.5 g.%)	(11.5 g.%)
Daily intake of Calories	...	...	...	1,865	1,662
Total protein	...	...	...	63.5 g.	46.7 g.
Animal protein	...	...	...	41.0 g.	28.0 g.
Total iron	...	...	...	10.77 mg.	9.21 mg.

It is perhaps a little difficult to evaluate the precise significance of these facts. That the anaemia was in fact primarily an iron deficiency state is indicated by the rise in the Hb. values obtained with the use of iron medication in a few cases. The precise details of the investigation and of the dietary analysis will be published shortly in the *Journal of Hygiene*, and the figures regarding Calorie and protein intake are thought accurately to reflect the state of affairs in the two hospitals. They suggest that though primarily an iron deficiency state, the anaemia may, in some way, have been conditioned by the low total and low daily protein intake.

The second question to which I wish to refer is that of obtaining accurate haemoglobin readings. We originally started with three haemoglobinometers of the Haldane pattern. One, originally made some years ago, had at one time been checked against Price-Jones' own standard and had been since restandardized more than once. The other two were made by a reputable firm, and had been standardized before delivery to us. They agreed within the limits of personal error with the first standard. Each of three observers kept a standard for his or her own use. Within three months obvious discrepancies in results became apparent, and it was found that the two recently acquired standards now appeared to be paler than the first, with the consequence that readings were, in one case 8%, in the other 7% higher. Restandardization of the first standard showed that it had remained accurate.

A similar error, leading to haemoglobin estimations inaccurate by as much as 13% was introduced when some readings were taken with a Sahli apparatus the glass of which had, in this case, darkened during two years of use in a hospital pathological department.

A second, and more important source of error is that due to local changes in haemoglobin and red cell concentration at the site of the prick. Dr. Mackay has already alluded to the differences that may be found between blood drawn from the ear and from the finger or foot of small children. The importance of obtaining *freely flowing blood* from a *warm limb* cannot be overestimated. Many of our estimations were made during the coldest winter months on children attending class in schools, and we had, at times, the utmost difficulty in obtaining consistent results even when each child was made to warm the whole limb in hot water. The errors introduced by using cyanosed blood or blood which had perforce to be expressed were frequently in the region of 10%, and even 15% and 20% fluctuations were obtained on the same child on the same day. Table II shows some estimations done on a group of children on a moderately warm September day when hot water was not available, compared with estimations done a few days later when the limbs had been previously warmed to redness by immersion. It also shows the haemoglobin figures obtained from the limbs of a healthy infant who normally had rather congested, cyanosed extremities. One limb was exposed for ten minutes to the ward temperature and the other immersed in water at a temperature of 100°F.

TABLE II.

Subject	Hb. estimations		
	1st	2nd	3rd
1	83	83	81
2	74	68	68
3	73	58	60
4	83	70	68
5	93	92	92
Average of 14	82.5	78.3	78.9
Baby C			
	L. hand blue	R. hand red (10 min. in water)	
	85	73	

The existence of the subcapillary plexus of blood-vessels is well recognized and that they can act as blood depots is also probable. It has also been shown not only that when the skin is cold blood may stagnate in these depots for as long as thirty minutes or more but that stasis leads to considerable local haemoconcentration. It is easy to understand therefore how cold extremities, and particularly the exertion of pressure to obtain blood from them may give rise to misleading results.

## Section of Laryngology

President—V. E. NEGUS, M.S.

[November 6, 1942]

### The Mechanism of Swallowing

PRESIDENT'S ADDRESS

By V. E. NEGUS, M.S.

*Methods of swallowing.*—A simple type of protozoan such as amoeba engulfs food by protoplasmic flow; part of the organism wraps itself round the particle and ingests it. In higher types this unicellular action is replaced by a multicellular mechanism, in which many cells combine to engulf food by concerted action. Longitudinal muscle fibres contract and pull part of the food tract over the bolus, which is then prevented from escaping by contraction of circular fibres and is carried downwards by their peristaltic action. Sebileau and Truffert [37] used the word "happer"—to snap up—in describing the movement of elevation over a bolus. As the wave descends there is relaxation of the longitudinal muscle and thus a section of the food passage descends, carrying with it the enclosed mass of food. Such a mechanism may be watched in snakes, which seem to creep forward over their prey. A rabbit, for instance, when swallowed, remains almost stationary, the snake moving forward over it until it has completely engulfed its victim. A simple mode of swallowing is employed by the earthworm (*lumbricus*) which grasps food with its prehensile mouth and then squeezes it onwards by contraction of its muscular pharynx. A somewhat similar mechanism is to be discerned in mammals and man if various complicating factors are ignored.

*Alternative methods.*—An alternative method is that of ciliary action, as seen in vorticella amongst unicellular organisms and also in molluscs, such as oysters, in amphioxus, and in amphibia, as for example the frog (*rana*). In the latter, cilia extend into the oesophagus and may be observed to possess sufficient power to convey pieces of paper from the front of the mouth into the gullet. In man the use of ciliary action is confined to the conveyance of bacteria and particles of dust from the nose and sinuses to the nasopharynx.

*Other purposes of swallowing.*—Not only does the mechanism convey food to the stomach, but in certain species it also subverts the functions of smell and respiration. Some fish, for instance, induce a stream through the olfactory organ and carry water to the gills by swallowing movements, while lung fish (*dipnoi*) transfer air to the lung by a similar method.

In man the ingestion of food is the most important use of swallowing; but subsidiary purposes are the removal of bacteria from the nasopharynx, where they are deposited from the nose, the paranasal sinuses and the middle ear. Bacteria from the lungs are carried upwards through the larynx by ciliary action and are deposited in the pharynx, to be swallowed and destroyed in the acid secretions of the stomach.

*Modifications due to mastication.*—The concerted action of longitudinal and circular muscle fibres is able to propel food, and is efficient in such simple animals as earthworms, which live on small particles, grasped by the prehensile mouth. When large masses are swallowed, as in carnivorous fish and reptiles, some efficient means of seizing and holding the prey is necessary and takes the form of teeth, but without other modification of the

TABLE III.—A COMPARISON OF ANÆMIA IN THREE GROUPS OF SCHOOL CHILDREN (5-12 years).

	No. of cases	Percentage of children in different hæmoglobin ranges			
		Hb. <71%	Hb. 71-80%	Hb. 81-90%	Hb. >90%
Edinburgh, 1942 ...	389	8	45	40	7
London, Mackay, 1942 ...	128	53		47	
Aberdeen, Davidson, 1935	67	42		58	
		0		100	

It will be appreciated that in peace-time, economic status is the chief factor influencing the nutrition of individuals; in war-time, on the contrary, "rationing" and the difficulty in obtaining some unrationed foods constitute the chief limitations which, broadly speaking, are operative irrespective of income. This is probably the explanation of the higher incidence of anæmia noted by us during the present year in spite of the high figures for family income recorded.

**Dr. John Yudkin (Cambridge):** I have recently examined 300 mothers and children in Scotland and I also found a decrease in hæmoglobin compared with published figures, although this was not as great as that found by Prof. Davidson. Dr. Sinclair found that there appeared to be a fall in hæmoglobin in 1942 compared with 1941, but in the 400 factory workers whom I examined in 1941 and again in this year there was a slight rise of hæmoglobin. The suggestion of Dr. Sinclair that vitamin C deficiency might play a part in the increase of anæmia during the war is an interesting one, although Dr. Glazebrook and his co-workers have shown that the addition of this vitamin to the diet of naval ratings deficient in it did not produce any change in hæmoglobin.

There are many points on which workers are still not agreed—the best methods of obtaining samples of blood, technique of estimating hæmoglobin, whether or not there is a real increase in anæmia and if so what is its cause and what methods should be advocated for dealing with the situation. The many workers in this field should not continue their investigations in comparative isolation but should keep in close touch and compare results. Had a Nutrition Council been in existence one of its functions would certainly have been to form an "Anæmia" Committee to discuss the problems raised to-day, and to decide on the best methods of solving them. But even without a Nutrition Council the formation of such a committee would be of considerable value.

**Dr. T. S. Marshall: Summary.**—I am at present engaged on estimating the hæmoglobin level in blood donors. None of the donors upon whom I have made the estimation had donated blood before, and they all considered themselves to be in perfect health. In each case, a history of past and present illnesses was taken, with special reference to anæmia. A menstrual and obstetric history was taken in females (I consider this to be a very important point). My results are as follows:

100 males with a mean hæmoglobin of 100%.

65 women (after the reproductive period of life) with a mean hæmoglobin of 84%.

220 women (in the reproductive period of life) with a mean hæmoglobin of 82%.

All estimations were made on capillary samples taken from the middle finger of a warmed hand, after the subject had been in a recumbent position for twenty minutes. [This latter point I think plays an important part, because donors arriving after bicycling or hurrying, showed a difference of 12-18% in their hæmoglobin level taken immediately on arrival, and after twenty minutes recumbency. This is a possible explanation of the high figure recorded by Dr. Mackay in her factory workers.]

The hæmoglobinometer used was Haldane-Gowers, standardized at the National Physical Laboratories recently.

with an efficient flap which lies either below the palate or above it in the nasopharynx; the palate is elongated to complete the junction.

Herbivorous animals such as deer and cattle and hunters like the members of the dog tribe show this structural arrangement. To ensure efficient coaptation of the larynx and nasopharynx lateral palatine folds descend on either side of the epiglottis, with palato-glossal and palato-pharyngeal muscles enclosed within their layers. Contraction of these muscles keeps the palatine folds taut, and brings them efficiently into contact with lateral epiglottic folds, thus ensuring passage of air over the olfactory nasal mucous membrane even when the mouth is open, as during cropping of herbage.

When the ingestion of any large bolus takes place the palatine folds must be separated from the epiglottis to give free passage; deglutition is then divided into three stages, the first through the mouth, the second past the larynx and the third through the œsophagus.

Man relies for his preservation on vision and not on his sense of smell, and has therefore no need of this intimate relationship of laryngeal and nasal airways.

*Combined respiration and deglutition.*—Animals such as herbivora, which eat large quantities of vegetable food, would be handicapped if respiration had to cease while food passed into the gullet. To overcome this difficulty the larynx is provided with high lateral margins, which in most species take the form of aryepiglottic folds. The larynx thus assumes a spout-like character, with a lateral food channel on either side. Further to prevent entrance of fluids there is evolved an arcus palato-pharyngeus, a fold made up of the fused palatine arches meeting posteriorly, with an enclosed palato-pharyngeal sphincter, designed to grasp the laryngeal aperture and thus to shut off the lateral food channels from the airway. This structure is present in most herbivora and appears, in its most efficient form, in cetaceans such as porpoises, dolphins, and some whales. Fœtal marsupials attached to the maternal nipple and fed forcibly by the mother, show the mechanism well. Man has abandoned the purely herbivorous habits of his ancestors and with his mixed diet has no need of an efficient lateral food channel. A further reason for his departure from the herbivorous type of lateral passages is the recession of the jaws and the flexion of the head on the vertebral column; the larynx has descended in the neck, being forced to do so by the tongue, which assumes an arched shape [35]. The result is the separation of larynx from nasopharynx, with a wide gap between epiglottis and soft palate, and the formation of a capacious and lengthy pharynx. There is an angle of almost ninety degrees between the mouth and pharynx. The descent of the larynx in the neck and the absence of any close relationship with the nasopharynx, make it essential that both nasal and laryngeal passages should be closed during deglutition, to prevent inundation. Only when very small quantities of liquids, food or of saliva are passing is it possible for the laryngeal aperture to remain open.

*Mechanism of the nasopharynx.*—Closure of the nasal airway is a complicated action in which several muscles play a part. As food is forced back into the pharynx, reflex stimulation of the posterior wall initiates a swallowing movement [27], commencing in the highest part of the nasopharynx and travelling down as far as the mouth of the œsophagus. The first movement appears to be carried out by longitudinal elevator muscles, the levator and tensor palati, closely followed by the salpingo-pharyngeus and the palato-pharyngeus. The uppermost fibres of the latter are almost horizontal and act as the sphincter of the hiatus naso-pharyngeus, situated just above the lower border of the soft palate. This view of the anatomy is taken by Wood Jones, who refers to the observations of Townshend [20]; previously the sphincter had been ascribed by Wardill [41] and Whillis [42] to fibres of the superior constrictor.

The primary movement of the elevator muscles leads to raising of the soft palate and closure of the nasopharyngeal isthmus by approximation of all its walls; initial closure is followed by a wave of constriction, effected by the superior constrictor muscle, with the object of squeezing out mucus, debris and bacteria, dumped by the ciliary streams of the nose and sinuses, to be carried downwards through the pharynx into the œsophagus and stomach.

When the mechanism is upset, as in the paralysis sometimes following diphtheria, there may be regurgitation into the nose. Scarring and immobility may lead to stagnation of infected secretions, with consequent droplet infection of the lungs.

*Closure of larynx during deglutition.*—When any considerable quantity of food or fluid is swallowed, respiration ceases and both nasopharynx and larynx close. At the beginning of the second stage of deglutition the larynx rises with the rest of the pharyngeal tube. Contraction of the thyrohyoid muscle, together with the upward pull of the palato-thyroideus [20], causes the thyroid cartilage to ascend beneath the hyoid bone, thus bringing the whole larynx into apposition with the base of the tongue. At the same time the



simple mechanism. In snakes the teeth are set back so that the prey when caught cannot escape; the teeth are not used for mastication. Crocodilians similarly use their teeth for prehension only. If food is divided up in the mouth, instead of being ground up in the gizzard, as in earthworms and birds, or digested in the stomach, as in reptiles and crocodilians, grinding teeth are necessary; the chewing process also requires the presence of a tongue to force food between the teeth, and cheeks to prevent escape of the divided mass.

*Function of cheeks and lips.*—Cheeks are almost absent in amphibians, reptiles and birds and are but poorly developed in carnivorous mammals. Herbivora, on the other hand, have efficient cheeks capable of retaining masticated food; man is similarly well provided. Mobile and prehensile lips are associated with efficient cheeks, as may be noticed in monkeys, apes and man [35].

*Uses of tongue.*—The tongue is used not only for purposes of mastication but also for prehension, as in chameleons and toads, where it is used for catching flies; herbivora, such as giraffes, carry leaves to the mouth with their long prehensile tongues. A further function of the tongue in many animals is propulsion of food into the pharynx; in man the organ arches up and is pulled back by the palatoglossus and styloglossus muscles, thus tipping food into the pharynx. Some carnivora, such as crocodiles, have a flat and relatively immobile tongue, unrequired for mastication, unsuited to prehension and of little use for propulsion; others, as for example dogs, have a mobile tongue capable of forcing unmasticated lumps of food backwards. The absence of tongue and cheeks sometimes makes the swallowing of lumps of food difficult, as may be noticed in the hen, for instance; this and other birds make snatching movements by jerking the head forward, thus utilizing the inertia of the bolus as a means to engulf it. In man total removal of the tongue does not lead to inability to swallow, owing to the compensatory action of the cheeks and floor of the mouth.

*First or buccal stage of swallowing in man.*—Prehensile lips assist in grasping food, which is masticated by combined action of the tongue and teeth; the latter are adapted to grinding but are not so efficient as in the progenitors of modern man, owing to reduction of the palate area. Well-formed and muscular cheeks prevent escape of masticated food. The bolus is forced backwards by raising of the floor of the mouth, mainly by action of the mylohyoid muscle, with arching and backward movement of the tongue; amongst the muscles concerned in these two movements are the intrinsic muscles of the tongue, the hyoglossus and the stylo- and palato-pharyngeus. The backward movement of the tongue temporarily obliterates the lumen of the pharynx, while the isthmus of the fauces is at the same time narrowed. When the bolus passes the fauces it enters the pharynx, where certain difficulties arise in its transference, due to the necessities of respiration. The passage of the bolus from this point to the mouth of the œsophagus is called the second stage of swallowing. Various considerations in connexion with modifications of the mechanism in this region must now be considered.

*Modifications due to presence of larynx.*—The development of a pulmonary outgrowth does not of itself involve any radical change in the mechanism of swallowing. In lung fish (dipnoi) for example, the larynx is small and lies flat in the floor of the pharynx; similarly in such reptiles as tortoises, crocodiles and lizards and in birds, movements of the longitudinal and circular muscles are not impeded by the larynx. Deglutition takes place as one continuous action, after initial prehension of food and its passage through the mouth; but in other higher animals the larynx has a marked effect on the mechanism.

*Complications caused by nasal respiration.*—Even though the evolution of a pulmonary system does not necessarily have a pronounced effect, yet the habit of breathing through the nose may introduce certain modifications in species where it is necessary for the nasal and laryngeal airways to be continuous. Such a relationship is evolved for various reasons, depending generally on the desirability of maintaining nasal respiration when the mouth is open.

Reptiles have poor powers of scent and do not derive any particular benefit from breathing through the nose in respect of olfaction. Keen-scented animals are, however, in a different category and accordingly show certain alterations of structure.

*Modifications due to presence of epiglottis.*—If it is desired to preserve the integrity of the olfactory sense when the mouth is open, whether for selection of suitable food, or to detect the presence of enemies, it is necessary for the airway to be shut off from the food tract. The epiglottis is evolved for olfactory purposes, to form a barrier against mouth breathing, by coming into relationship with the palate [30]. Most amphibians, reptiles and birds are devoid of an epiglottis, but keen-scented mammals are provided

contraction of the opposite and active constrictors. This is the curtain movement described by Vernet [40].

There may be, in addition, lateral deviation of the thyroid cartilage, the sign of Adam's apple referred to by Ledoux [25].

The opening of the pharynx at the beginning of the second stage appears to depend on contraction of the elevator muscles, with relaxation of the palato- and stylo-glossus.

The lumen of the pharynx thus opens up as the backward push of the tongue ceases. It is again closed by the peristaltic wave of the constrictor muscles; but before this wave descends, the bolus of food, if not too hard or bulky, may have passed rapidly down the opened pharynx. The question of the suction effect stressed by Barclay [1, 2, 3] will be referred to later.

*Closure of mouth of the œsophagus.*—In animals which suck air into the lungs by expansion of the thorax and descent of the diaphragm, the bellows action would, if no barrier existed, suck air more readily into the œsophagus than into the lungs.

To prevent this undesirable occurrence, the crico-pharyngeal sphincter is present at the mouth of the œsophagus to keep the gullet closed during respiration, as described in previous contributions [31]. Insufficient interest has been taken in this important muscle band, and although it was described many years ago, yet no reference to it is made in most textbooks of anatomy and physiology. Keith [21] recognized the sphincter as being constituted by the lower part of the inferior constrictor, the upper part of which has a propulsive action. He referred to its relaxation in the act of swallowing and wrote: "Like the sphincter at the pylorus, that at the upper end of the œsophagus is continually in action, except during the initial act of swallowing." He mentioned that, unknown to him, a description had already been given by Killian [22, 23], and he also referred to the writings of Sir Everard Home [10], who compared the sphincter to that of the urethra.

Chevalier Jackson [15, 16, 18, 19] observed the obstruction offered by the sphincter on passing an œsophagoscope and described the muscle band as long ago as 1907; and subsequently in many contributions he gave prominence to its importance in deglutition.

Relaxation of the sphincter occurs when a signal is given by the sensory stimulation afforded by impact of a bolus of food on the posterior pharyngeal wall. The mouth of the œsophagus opens as the larynx closes, while respiration is temporarily suspended.

The fibres of the crico-pharyngeus meet posteriorly in a median raphe continuous with that of the oblique fibres of the inferior constrictor. They are anchored to the front of the vertebral column by virtue of atmospheric pressure, in addition to attachment of the covering bucco-pharyngeal fascia to the prevertebral fascia.

When the sphincter is contracted there is a backward pull on the larynx. When relaxation occurs, early in the second stage of swallowing, the larynx is released and tends to fall forward in response to contraction of the thyrohyoid and other muscles. The capacity of the pharynx is thus increased, affording a clear space for downward passage of food, as stressed by Barclay [1; 2, 3].

The sphincter receives its motor supply from the nucleus ambiguus through the vagus and its recurrent branches; the sympathetic sends fibres also and according to observations of Lambert Rogers [36] they all come from the superior cervical ganglion. By removal of the sympathetic supply Lambert Rogers has produced relaxation of the sphincter; it may therefore be concluded that the vagus is the relaxor and the sympathetic the contractor of the muscle band. The vagus thus has an opposite action on the oblique and circular fibres of the inferior constrictor muscle, leading to contraction of the former and relaxation of the latter. The sympathetic is reputed to augment the action of the vagus in the upper third of the œsophagus [24] but apparently it has an opposing action on the sphincter. The crico-pharyngeus remains in contraction when the inferior constrictor and muscles of the upper œsophagus are relaxed, all being controlled by the vagus; propulsive waves in the pharynx during deglutition are associated with relaxation of the sphincter, the sensory fibres of the vagus giving the necessary signal. But when there is prolonged irritation of the lower pharynx or upper end of the œsophagus—either from the presence of a foreign body, a neoplasm, acute or chronic inflammation or ulceration—initial swallowing efforts to dislodge the cause of irritation are succeeded by lack of relaxation or achalasia [13]. Sometimes increased contraction, even amounting to spasm, is present. This reversed effect of excessive sensory stimulation is remarkable.

Deficient relaxation of the sphincter appears to be an important factor in the causation of pharyngeal diverticula [18]; the bolus of food, forced down by peristaltic contraction of the constrictors, causes herniation of the weak and relatively unsupported area between the lowest oblique fibres of the inferior constrictor and the crico-pharyngeal sphincter, as described by Keith [21]. On the other hand, undue relaxation of the sphincter may

sphincters of the larynx contract, while the dilators relax, in order to close the airway before food has the chance of entering.

The simple sphincter of lung fish is represented in man by the paired lateral crico-arytenoid and thyro-arytenoid muscles and the single interarytenoid, with certain oblique fibres running from the latter to the epiglottis. A few strands pass the epiglottis to be attached to the hyoid bone, thus assisting in the elevation of the larynx.

In dogs some fibres may be seen passing from the sphincteric group to the anterior wall of the œsophagus, to assist in opening the mouth of the latter [32]. Sebileau has described similar fibres in the horse [37]. In man these fibres are less obvious, but there is an alternative mechanism with a similar function, namely suspension of the anterior wall of the œsophagus from the tips of the recurved cartilages of Santorini. These processes are tilted forward by the underlying interarytenoid muscle during swallowing, thus serving to close the larynx and open the œsophagus simultaneously [32, 33]. In these movements the anterior wall of the hypopharynx is partially pulled up over the top of the cricoid cartilage, thus helping to close the laryngeal aperture.

It is generally recognized, in agreement with Anderson Stuart [39], that the epiglottis does not serve as a lid for the laryngeal aperture; rather it appears to be squeezed between the base of the tongue and the upper boundary of the larynx [7]. Many animals amongst the lower orders, and walrus and sea lions amongst mammals, are provided with no more than a rudimentary organ and yet suffer no inconvenience; nor does a man whose epiglottis has been removed.

Although the larynx of man may remain open when small quantities of fluid pass along the lateral food channel, yet insufficiency of the latter makes it necessary for closure to take place when any large amount is swallowed. Even so the food stream does not habitually pass over the larynx, but is diverted to one or other side. Observations have been recorded by Grahe [8] to show that the lateral food channel of one side only is used by most individuals, to the exclusion of the opposite side. This may have some bearing on the causation of malignant disease in the pyriform fossa.

In many animals, as already noted, closure of the larynx during deglutition is not necessary.

*Mechanism of second or pharyngeal stage in man.*—Having traced the evolutionary changes which have divided swallowing into three stages, it is now desirable to study further the second stage, in which food passes from the level of the palatine folds to the mouth of the œsophagus.

In man, the descent of the larynx, dependent on flexion of the head and retrogression of the jaws, has considerably increased the length of the pharynx [35] and has altered the anatomical distribution of the longitudinal and circular muscles; but there seems no good reason to think, with Ledoux [25], that the mechanism is materially changed.

The longitudinal or elevator muscles consist of the stylo-pharyngeus, palato-pharyngeus and palato-thyroideus, working in association with the levator and tensor palati, the salpingo-pharyngeus and the elevators of the hyoid bone and larynx; of the latter group the stylohyoid and thyrohyoid are important members. Clarification of the distribution has been made by Wood Jones [20]. The circular group is made up of the three constrictors. The latter differ in their arrangement from the corresponding muscles of mammals, the fibres of the inferior constrictor having a considerable upward inclination from their origin on the larynx to their insertion in the posterior median raphe. But the mode of action of the pharyngeal musculature appears unchanged, as may easily be observed in the pharynx of a partially anesthetized patient whose mouth is widely opened.

Each movement of swallowing can be seen to consist of primary elevation, in which the fibres of the middle and inferior constrictor are brought into a more horizontal position, followed by a peristaltic wave of constriction flowing rapidly and smoothly down the tube-like pharynx. The larynx, forming part of the anterior wall, rises with the rest of the pharynx and again descends when the bolus is engulfed and carried downwards to the mouth of the œsophagus; the whole wall of the pharynx rises and falls in this multicellular engulfing movement. Ledoux, in contradistinction, considered the middle and inferior constrictors to act as elevators of the larynx and described the longitudinal muscles as accessory elevators.

Although this mechanism is not always required in man, yet it is available and is essential in such animals as giraffes, whose food passage slopes upwards during feeding. Considerable force may be exerted on a bolus of food, as noted in cases of pharyngostome. Bilateral paralysis of the muscles, as in bulbar palsy, may lead to inability to swallow, while unilateral paralysis, due to such conditions as thrombosis of the posterior inferior cerebellar artery, causes considerable disability, with lateral movement of the affected side during

Hurst considers it to be situated in the abdominal segment of the œsophagus, usually extending up to the level of the diaphragmatic hiatus [11, 13].

Cannon [5] has shown that in the normal cat regurgitation from the stomach to the œsophagus is a common occurrence, the fluid being again returned to the stomach by peristalsis; but when the gastric contents become acid during digestion, their effect is to keep the cardiac sphincter closed, apparently to prevent regurgitation. Much experimental work has been carried out on the nerve supply of the sphincter; Hurst has studied the subject in detail [11, 12, 13, 14]. The observations of Knight [24] may also be quoted. The sphincter is supplied by both vagus and sympathetic nerves; stimulation of the former causes relaxation, while the latter leads to increased activity. The sympathetic fibres surround the celiac axis and left gastric arteries; excision of this supply causes the sphincter to become completely patulous, with consequent regurgitation into the œsophagus. In cats, division of the vagal supply to the œsophagus causes dilatation, with holding up of food by contraction at the cardia; division of the sympathetic fibres leads to cessation of all symptoms. Hurst believes that the cause of a similar condition in man is degeneration of Auerbach's plexus [14], with consequent blockage of the stimulus to relax. There is no dispute with these experimental findings in the cat, but other considerations appear to arise in man, both in normal deglutition and in diseased states.

All opinions consider the sphincter to be very feeble and in no way comparable to the sphincters of the bladder, the rectum, or the mouth of the œsophagus. It is easily forced by œsophageal contents, and in cases of œsophagectasia offers but little resistance to a mercury bougie, as observed by Hurst [13, 14].

I have never seen evidence of its existence on direct œsophagoscopy. As regards disordered action of the sphincter, if one exists, some have described over-action, producing the disease generally known as cardiospasm; but there is no hypertrophy of the sphincter in this type of œsophagectasia [14].

Others, and notably Hurst, consider lack of relaxation or achalasia to cause holding up of food in the œsophagus, with the proviso that the sphincter is situated just below the diaphragmatic hiatus, where the hold-up occurs, and not at the actual junction of abdominal œsophagus and stomach. But if the disease were caused by achalasia, hypertrophy of the œsophageal musculature, present in many cases, should easily overcome the feeble resistance of the sphincter, and in fact is thought by Hurst to do so in the early stages of the disease. Resistance by the sphincter alone does not appear to explain the progress of the complaint, in view of the feeble obstruction offered, even in severe cases. Further evidence as regards the cardiac sphincter is obtainable in those cases of short œsophagus with no organic stricture at the junction of œsophagus and thoracic segment of the stomach. When one passes an œsophagoscope in such a case the line of demarcation between œsophageal and gastric mucosa is obvious and sharply defined; but never does one see evidence of a sphincter. Furthermore it is common experience in such cases, to find reflux of gastric secretions into the œsophagus, with peptic ulceration; Dick and Hurst [6] in fact consider shortening of the œsophagus to be a common factor in this type of œsophageal disease. In a paper by Briggs and themselves it is stated that: "The cardiac sphincter appears to be permanently relaxed when the œsophagus is abnormally short and a portion of the stomach is above the diaphragm; this is in contrast with the normal condition, in which it is closed except when relaxation occurs in the last stage of deglutition" [4]. In view of the consensus of opinion that the cardiac sphincter is feeble, if in fact it exists, it is desirable to consider whether other means are available to prevent regurgitation from the stomach. I have long felt, and am not alone in my opinion, that local physical conditions are such as to make a muscular sphincter unnecessary.

Gubarof [9] is quoted as believing in the theory of mechanical as opposed to muscular closure, and the Ducuings [7], who refer to the paper of the above author, also consider this possibility. Dick and Hurst [6] refer to a cardiac valve, formed by the left lip of the abdominal œsophagus as it joins the stomach; they believe it to act in one direction only and to assist in preventing regurgitation, while offering no impediment to the entrance of food into the stomach.

A factor which appears to have been somewhat overlooked is the difference in physical conditions to which the thoracic and abdominal segments of the œsophagus are subjected. In the thorax there is normally reduced pressure, tending to open the œsophagus, while in the abdomen the pressure is raised, with mutual apposition of the viscera, thus closing the abdominal œsophagus [34]. The difference of pressure and degree of obstruction are greater during inspiration, due not only to expansion of the ribs and descent of the diaphragm, but also to contraction of the crura and narrowing of the hiatus. For this reason and not because of varying degrees of contraction of a sphincter, a bolus of food may be halted during inspiration, to enter the stomach when expiration commences:

permit air sucking or air swallowing, with distension and subsequent dilatation of the entire thoracic œsophagus, leading to œsophagectasia, with all the signs and symptoms of the disease usually known as cardiospasm [34]. This theory of primary dilatation probably applies to many cases in which no primary obstruction is present. Animals with no lungs, those with infrabuccal bellows and those filling the lungs by swallowing movements have not the same need as man of a sphincter at the mouth of the œsophagus.

*Passage of food into and through the œsophagus.*—It has been mentioned above that relaxation of the crico-pharyngeal sphincter is followed by increase in the capacity of the pharynx. The simultaneous opening of the œsophagus allows the normally reduced intrathoracic pressure to exert a suction effect, particularly during the inspiratory phase of respiration. It is thus possible for food to drop through the laryngo-pharynx into the funnel-like mouth of the œsophagus in advance of the peristaltic wave which descends to propel any lagging bolus. This suction action was described by Maissiat [26] and has been brought into prominence by the radiological studies of Barclay [1, 2, 3].

The rapid rate of progress may continue in the upper part of the œsophagus, after which partial equalization of pressure, incidental to opening of the sphincter, leads to slowing of the bolus. In this connexion it is stated that reflex inhibition of tonus of the upper end of the œsophagus accompanies relaxation of the crico-pharyngeal sphincter, thus delaying the commencement of the peristaltic wave [38].

Through the remainder of the œsophagus, passage of the bolus may be effected by gravity, but the normal propelling force is muscular action; by co-ordinated action the elevating longitudinal and sphincteric circular components execute movements of engulfment, shortening being succeeded by a peristaltic wave. That peristalsis is a means of propulsion of food is shown by the ability to swallow with the head lower than the body, as in human beings lying in an inclined bed, or in animals with long legs.

The nerve supply of the œsophagus has been the subject of a considerable amount of experimental work; the observations of Knight [24] have clarified the position. The vagus gives branches to the musculature, both from its main trunk and also through the recurrent laryngeal nerve; it produces, by its action, increased tonus in the thoracic œsophagus. Stimulation of the supply to the upper third causes temporary tetanic contraction; the sympathetic has a contributory effect. In the middle third stimulation of the vagus increases tonus, augmented by the sympathetic; in the lower third the vagus acts in a similar manner but is opposed by the sympathetic.

Paralysis of both vagus nerves causes dilatation of the œsophagus with decreased motility; peristalsis later recovers in the lower third. The dilatation of œsophagectasia or cardiospasm cannot usually be due to decreased vagal action, however, since many cases show hypertrophy of the musculature and not wasting. Wide dilatation of the œsophagus, such as occurs in cases of cardiospasm and congenital shortening, makes the peristaltic wave ineffective; swallowing of air has already been mentioned as a possible cause of the former condition. Clinical and radiological observations show that patients with œsophagectasia rely on gravity as a means of carrying food onward. Peristalsis, under such conditions, cannot bring the walls of the gullet into approximation and the muscular wave merely churns up the contents, with no propulsive effect. In attempts to close the lumen, so as to overcome the disturbance of the normal mechanism, the musculature may hypertrophy. This explanation appears, in the case of œsophagectasia with holding up at the diaphragm, to be as reasonable as that which considers the muscular overgrowth to be a response to obstruction; the slight degree of the latter, to be referred to later, should readily be overcome if hypertrophy followed obstruction early in the disease and wide dilatation should therefore not occur. As soon as the muscular hypertrophy fails to compete with the abnormal dilatation of the œsophagus there is only one method for conveyance of food into the stomach, and that is the force of gravity.

*Mechanism at lower end of œsophagus.*—It is not necessary, for physiological reasons, that any obstruction should be offered to the entrance of food or fluid into the stomach. On the contrary, it is desirable that the contents of the œsophagus should pass onward as rapidly as possible, since stagnation is liable to cause œsophagitis. But it is essential that regurgitation should be prevented, not only to prevent the loss of gastric contents, but also to avoid peptic digestion of the mucosa in the lower end of the œsophagus.

Once in the stomach the contents are constantly forced onwards towards the pylorus by muscular contraction and are only temporarily arrested by the pyloric sphincter, until of suitable consistency to enter the small intestine. In the opposite direction, however, there is normally little tendency for food to regurgitate, and but slight force is required to prevent its escape.

A cardiac sphincter has been referred to by many authors, but descriptions vary.

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All opinions consider the sphincter to be very feeble and in no way comparable to the sphincters of the bladder, the rectum, or the mouth of the œsophagus. It is easily forced by œsophageal contents, and in cases of œsophagectasia offers but little resistance to a mercury bougie, as observed by Hurst [13, 14].

I have never seen evidence of its existence on direct œsophagoscopy. As regards disordered action of the sphincter, if one exists, some have described over-action, producing the disease generally known as cardiospasm; but there is no hypertrophy of the sphincter in this type of œsophagectasia [14].

Others, and notably Hurst, consider lack of relaxation or achalasia to cause holding up of food in the œsophagus, with the proviso that the sphincter is situated just below the diaphragmatic hiatus, where the hold-up occurs, and not at the actual junction of abdominal œsophagus and stomach. But if the disease were caused by achalasia, hypertrophy of the œsophageal musculature, present in many cases, should easily overcome the feeble resistance of the sphincter, and in fact is thought by Hurst to do so in the early stages of the disease. Resistance by the sphincter alone does not appear to explain the progress of the complaint, in view of the feeble obstruction offered, even in severe cases. Further evidence as regards the cardiac sphincter is obtainable in those cases of short œsophagus with no organic stricture at the junction of œsophagus and thoracic segment of the stomach. When one passes an œsophagoscope in such a case the line of demarcation between œsophageal and gastric mucosa is obvious and sharply defined; but never does one see evidence of a sphincter. Furthermore it is common experience in such cases, to find reflux of gastric secretions into the œsophagus, with peptic ulceration; Dick and Hurst [6] in fact consider shortening of the œsophagus to be a common factor in this type of œsophageal disease. In a paper by Briggs and themselves it is stated that: "The cardiac sphincter appears to be permanently relaxed when the œsophagus is abnormally short and a portion of the stomach is above the diaphragm; this is in contrast with the normal condition, in which it is closed except when relaxation occurs in the last stage of deglutition" [4]. In view of the consensus of opinion that the cardiac sphincter is feeble, if in fact it exists, it is desirable to consider whether other means are available to prevent regurgitation from the stomach. I have long felt, and am not alone in my opinion, that local physical conditions are such as to make a muscular sphincter unnecessary.

Gubarof [9] is quoted as believing in the theory of mechanical as opposed to muscular closure, and the Ducuings [7], who refer to the paper of the above author, also consider this possibility. Dick and Hurst [6] refer to a cardiac valve, formed by the left lip of the abdominal œsophagus as it joins the stomach; they believe it to act in one direction only and to assist in preventing regurgitation, while offering no impediment to the entrance of food into the stomach.

A factor which appears to have been somewhat overlooked is the difference in physical conditions to which the thoracic and abdominal segments of the œsophagus are subjected. In the thorax there is normally reduced pressure, tending to open the œsophagus, while in the abdomen the pressure is raised, with mutual apposition of the viscera, thus closing the abdominal œsophagus [34]. The difference of pressure and degree of obstruction are greater during inspiration, due not only to expansion of the ribs and descent of the diaphragm, but also to contraction of the crura and narrowing of the hiatus. For this reason and not because of varying degrees of contraction of a sphincter, a bolus of food may be halted during inspiration, to enter the stomach when expiration commences:

pressure in the abdomen is then reduced, while the intrathoracic pressure is correspondingly increased.

A further factor of importance in closure of the abdominal œsophagus is the situation of the gullet in the liver tunnel of Mosher; it is here subjected to pressure from the left, exerted by the fundus of the stomach, especially when the air bubble is large. Distension of the stomach may be associated with an abdominal lesion such as gall-stones, gastric ulcer, or chronic appendicitis, and may lead to increased obstruction, in some cases followed by œsophagectasia. The possible benefit of dividing the sympathetic supply to the region of the cardia, recommended by Knight [24], may be explained by lessened inhibition of the gastric musculature, with diminution of stasis, and not by any effect on the cardiac sphincter. Kinking of an overlong œsophagus may add to the valvular obstruction and may necessitate œsophagolysis.

Mosher [29] has shown by detailed observations that the œsophagus folds on itself as it passes the left crus of the diaphragm; there is an alteration of direction from the vertical to the horizontal. The left lobe of the liver is in front of the horizontal segment and thus helps to close it. He has also demonstrated a close relationship of the lung tips to the œsophagus [28]. The right lung tends to go behind and the left in front; the total effect is not only a change of direction, but also a twist of the axis and a tendency to kinking and occlusion of the lumen. The effect is most marked when the diaphragm is down; during its rise in expiration the œsophagus tends to straighten out and open. Mosher believes that a cardiac sphincter exists, but not in every subject; he is of opinion that the physical factors outlined are the cause of closure of the terminal portion of the œsophagus.

Jackson [16, 17] considered specialized muscle fibres derived from the crura of the diaphragm to have a pinchcock effect; the lack of effective prevention of regurgitation during expiration by this means alone, if the fibres relax with the rest of the diaphragm, makes it necessary, however, to consider other possibilities. Jackson himself considered kinking of the abdominal œsophagus to play a part [16]. The evidence available appears to support the view that physical factors produce a mechanical compressive effect at the level of the diaphragm, sufficient to prevent regurgitation and calling for a mild propulsive effort on the part of the œsophagus.

If the propulsive force diminishes or if the obstruction increases, there may be holding up of food in the œsophagus, with signs and symptoms of the disease generally known as cardiospasm.

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## DISCUSSION ON NEUROLOGICAL DISORDERS OF THE MECHANISM OF SWALLOWING

Sir Arthur Hurst (*in absentia*): *Hysterical dysphagia*.—Theoretically there is no reason why hysterical dysphagia should not develop in the form of paralysis or inco-ordination of the voluntary muscles concerned in the first two stages of swallowing. Actually it is extremely rare. Whereas in the last war I saw over a hundred cases of hysterical aphonia and over fifty of hysterical vomiting in soldiers, I saw no case of hysterical dysphagia. Many years ago I made this diagnosis in a few middle-aged women, but I am now convinced that they were examples of the upper dysphagia and anæmia syndrome of Paterson.

*Dysphagia in organic nervous diseases*.—Dysphagia may occur in various organic nervous diseases as a result of paralysis of the muscles concerned in the first and second stages of swallowing. The œsophagus itself and the cardiac sphincter are never involved. In *diphtheria* the toxin ascends by the lymphatics of the nerves from the site of the lesion to the central nervous system, where it puts the cells of the corresponding nuclei out of action. The paralysis of the soft palate, which results in regurgitation of food through the nose, and the rare pharyngeal paralysis which results in severe dysphagia, occur therefore only in the common faucial diphtheria and not when the primary focus is in a wound, the conjunctiva or elsewhere. The paralysis is nuclear in origin and generally develops in the second week, in contrast with the more widespread paralysis caused by diphtheritic polyneuritis which appears between the third and sixth weeks.

In the *motor neurone disease*, which includes progressive muscular atrophy and amyotrophic lateral sclerosis, dysphagia may occur if the vagal nucleus is involved in the last stages of the common form which begins in the muscles of the hands. It always occurs in *progressive bulbar palsy*. Though myasthenia gravis is a primary muscular disease, it gives rise to a similar upper dysphagia, in which the first as well as the second stage of swallowing is affected. In the motor neurone disease the slowly progressive paralysis is unaffected by any treatment, and there is no variation in the course of each day, so that once nasal feeding is begun it has to be continued until death, which is not likely to be long delayed. In myasthenia gravis the dysphagia increases in severity as the day goes on, and spontaneous improvement may occur from time to time, so that a patient who has had to be fed for a time by nasal tube may later be able to swallow quite well for weeks, months or years. Improvement in swallowing sometimes seems to be a direct result of the complete rest given to the muscles of deglutition by nasal feeding. Slight dysphagia can sometimes be controlled like the other symptoms by  $\frac{1}{2}$  to 1 gr. of ephedrine taken an hour before meals. In severe cases an injection of 1 to 2 mg. of prostigmine may make swallowing possible for four or five hours, but it should be used only to tide over a period of great difficulty and not for long periods, as it may lead to increased weakness after the effect of each dose wears off.

*The upper dysphagia with anæmia syndrome of Paterson*.—The occurrence of upper dysphagia in anæmic women was first recognized by a member of this Section, D. R. Paterson, in 1906. In 1919 he described it more fully, but his observations attracted little attention, so that when in 1922 Vinson of the Mayo Clinic wrote an account of the syndrome and referred to unpublished work of his colleague Plummer in 1914, it was generally regarded as an original observation. I described a case as one of Plummer-Vinson syndrome in 1926, and unfortunately this name has ever since been widely used in England and America. When, shortly afterwards, I read Paterson's description, which was much more accurate than Vinson's, as he described the associated atrophic condition of the mucous membrane of the tongue, which I had also recognized, but which had been missed by Plummer and Vinson, who quite unjustifiably regarded the condition as hysterical, I suggested that the designation Plummer-Vinson syndrome should be replaced by "the upper dysphagia with anæmia syndrome of Paterson". The adoption of this name by members of the Laryngological Section will, I hope, result in justice being done at last to Paterson's admirable work. Paterson's syndrome is the most frequent cause of upper dysphagia. It occurs in about 15% of cases of the simple achlorhydric anæmia (also known as hypochromic or microcytic anæmia), which is common in women, especially between the ages of 30 and 50, and very rare in men. Severe cases, which would be likely to come to the laryngologist, are rare in comparison with the cases in which slight upper dysphagia is a minor symptom, so minor that the patients often do not mention it unless directly cross-questioned. The syndrome is the direct result of iron deficiency, which causes not only the anæmia, but also atrophy of the mucous membrane of the tongue and pharynx. The atrophic condition of the pharyngeal mucosa results in a loss of sensibility, so that the afferent side of the reflex upon which the second stage of swallowing depends is impaired. The orderly activity of the muscles involved in the complicated act, so well described by the President, is disorganized so that swallowing becomes difficult or impossible.



The iron deficiency is a result of a diet containing too little meat and green vegetables. It is generally associated with achlorhydria, which interferes with the adequate preparation of such iron as is present in the food for absorption in the intestines, and occasionally with disorders of the small intestine which prevent complete absorption. In many cases there is also excessive loss of iron from menorrhagia.

Administration of 30 gr. of iron and ammonium citrate three times a day is sufficient to overcome the anemia and often to restore the atrophic epithelial tissues to their normal condition, even when this occurs in the absence of anemia. If treatment is delayed, the atrophic pharyngeal mucosa may contract and aggravate the dysphagia by adding a mechanical to the neuromuscular disorder. In long-standing cases too, as Paterson was the first to point out in 1919, the atrophied tissues may undergo malignant degeneration. This explains why 80% of cases of epithelioma of the post-cricoid part of the pharynx occur in women, in contrast with carcinoma of the middle and lower end of the œsophagus, of which 80% occur in men. The dysphagia itself can be rapidly overcome by the passage of a large mercury bougie on a few occasions before complete recovery results from the taking of iron.

*Achalasia of the cardiac sphincter.*—The commonest nervous disorder of swallowing is achalasia of the cardiac sphincter. The obstruction to the onward passage of food at the lower extremity of the œsophagus, which is felt by the patient and is clearly visible when swallowing is watched with the X-rays, is not associated with any physical obstruction. At one time it was believed to be the result of cardiospasm, but the complete absence of hypertrophy of the sphincter at autopsy or when examined in the course of a laparotomy, even when it had been present for twenty years or more, shows that this cannot be the cause. The sphincter forms a neck, 1.5 to 4.5 cm. long, with no lumen, which separates the dilated part of the œsophagus from the stomach. Further evidence against cardiospasm is the absence of resistance to the passage of a mercury bougie and of gripping when the bougie is withdrawn, in contrast with the obstruction and gripping observed in anal spasm on introducing a finger. In 1915 I suggested that the obstruction might be the result of absence of the relaxation of the sphincter, which normally occurs when each peristaltic wave conveying food through the œsophagus reaches it. I was at that time unaware that a similar suggestion had been independently made in 1888 by Einhorn and in 1896 by Rolleston and, most remarkably, in 1672 by Thomas Willis.

I asked Sir Cooper Perry to invent a word for "absence of relaxation"; he proposed *achalasia* from *a*, not, and *χαλασις*, relaxation, and the designation achalasia of the cardiac sphincter has now almost universally replaced the incorrect cardiospasm.

I believe that achalasia of the cardiac sphincter accounts for every case of mega-œsophagus. In 1924 I suggested that it might prove to be the result of organic disease of Auerbach's (myenteric) plexus. The following year this hypothesis was proved to be correct in one early case by my house-physician, G. W. Rake, who subsequently found inflammatory or degenerative changes in the plexus in all of the eleven specimens he was able to collect. Similar changes in the plexus have been demonstrated in every one of 41 other cases in which it has been examined (Cameron, 8; Mosher and McGregor, 1; Beattie, 1; Rieder, 2; Etzel, 16; Lendrum, 13). Etzel and Lendrum have shown that the vagus itself is not affected, the lesion being confined to the ganglion cells which form a relay station for the vagus on its way to the muscle fibres of the œsophagus. The number of ganglia was always much diminished, and frequently none could be found. In some cases there was evidence of active inflammation, in others fibrosis, and in others simple atrophy.

The weight of the column of food in the dilated œsophagus after a meal is sufficient to force a small proportion of the fluid present through the sphincter as a narrow stream; but as soon as the height of the column falls below a certain point, generally about seven inches, or the individual lies down, the pressure becomes insufficient and the flow ceases. Consequently, stagnating food mixed with mucus is always present in the œsophagus, and a considerable quantity can be expelled from it even after a fast of twenty-four hours, either voluntarily by the patient or with a tube. No regurgitation occurs on lying down, as the pharyngo-œsophageal sphincter is always closed as in normal people except during the act of swallowing.

*Treatment.*—The simplest and most effective treatment is by means of a series of mercury bougies, the smallest of which is 24 and the largest 34 gauge. They are made of rubber tubes closed at the top with a rounded lower end and are half-filled with mercury. Three or four of increasing diameter can generally be passed at the first sitting. On a subsequent occasion a bougie should be passed with the guidance of the X-rays, and a mark should be made to show the position of the teeth when its lower end is in the right position—about two inches below the cardiac orifice. The largest bougie which the patient can himself pass should be chosen; this is generally No. 34. It drops easily through the sphincter and requires no pushing. It is kept in position for a quarter of an hour on each occasion. The patient feels relieved and realizes that the passage is clear as soon as it is withdrawn.

The bougie should be passed immediately before meals; the food, which should be well masticated, is then felt by the patient and seen with the X-rays to enter the stomach without difficulty. Some water should be drunk a quarter of an hour after each meal in order to cleanse the redundant mucosa. I once saw a patient a few hours after his food had stuck for the first time. After confirming the diagnosis with the X-rays I passed a mercury bougie, which resulted in an immediate and permanent cure. Generally, however, the tube has to be passed before the three chief meals at first, then once a day, and gradually less often, till finally it is used only at rare intervals when the patient feels that some slight obstruction is returning. In chronic cases, which are always associated with secondary œsophagitis, the diet for the first two or three weeks of treatment should consist of nothing but a pint of milk with the addition perhaps of a beaten egg, or glucose and fruit juice, three times a day immediately after the passage of the bougie. Half a pint of water should be taken ten minutes later. In the rare cases in which a mercury bougie cannot gain access to the sphincter owing to kinking caused by excessive elongation in addition to extreme dilatation of the œsophagus, the cardiac sphincter should be stretched by the fingers inserted through an opening made in the stomach after laparotomy.

Sir James Walton said the President's description of how in man there had developed the separation of the respiratory and swallowing functions had interested him for it was a general experience that when a person was suffering from a bad cold and the upper nasal tract was obliterated he was out of breath when eating. This was not the case under normal conditions, and he wondered whether the separation was complete. The fact that a man could hang upside down without vomiting made him also doubt the complete absence of a cardiac sphincter.

In man two factors were present in swallowing, namely, peristalsis and gravity. Peristalsis could act alone in man, as it could in the giraffe. When young they had probably all lain on a river bank and drunk with their heads down to the stream, so that gravity did not act at all. In cardiospasm peristaltic waves were, in the later stages, incapable of overcoming the obstruction at the cardia and gravity became an important factor.

All persons had the power of relaxing their œsophagus, some more than others. He had watched with astonishment how some men would take up a jug of beer and let it slide down their œsophagus. He did not agree, however, concerning the absence of regurgitation. He had always taught that one of the most definite symptoms of the presence of cardiospasm was that the patient would tend to get regurgitation when asleep.

He had always been interested in the question of the sphincteric action at the lower end of the œsophagus. It was assumed that there could be no spasm of the sphincter because there was no hypertrophy, but there was no evidence that spasm of an involuntary muscle in any part of the body ever produced hypertrophy. Congenital pyloric stenosis was not due to a spasm; it was due to a congenital abnormality in which there was hypertrophy of the muscle even before birth. The mere absence of hypertrophy was not an indication that there was no spasm. His own clinical experience was entirely in disagreement with that of Sir Arthur Hurst. In all the cases of cardiospasm—nearly 50—on which he had operated he had been able to demonstrate by passing a bougie the evidence of spasm at the lower end. Sir Arthur Hurst laid it down that failure of relaxation of the sphincter was due to atrophy of Auerbach's plexus, but he was more and more convinced that cardiospasm was a congenital fault. It was true that most of the cases were seen between the ages of 50 and 60, but they might have had it in a latent form throughout life. The youngest case he had come across—a typical cardiospasm as shown by the X-ray appearances—was in a child under 2 years of age. Therefore he must assume that it was a congenital fault, and that the degeneration of Auerbach's plexus was a secondary factor.

As for treatment, here it was only fair to say that a surgeon's view and a physician's view must be different. Of necessity he, a surgeon, saw the physician's failures, and the physician saw his, and therefore the disease was seen from rather a different angle. But he had never been convinced of the value of the passage of the mercury bougie. He had known cases in which the mercury tube had been passed, but the patient had had little or no relief, and he had seen many cases which had been treated by physicians who were advocates of the passage of the bougie, and its use had not led to a satisfactory result. In his own cases he had opened the stomach and dilated the cardiac sphincter. Care had to be taken lest by slight over-stretching the œsophagus might be torn, and that was almost always a disaster. Therefore the dilatation should not be done by an instrument but digitally. He practised the insertion of first one finger, then a second, and a third and a fourth. He aimed at getting the four fingers in, but it should be done with the fingers only. He had had no experience of the operation which Mr. Grey Turner supported, namely, anastomosis between the dilated and S-shaped œsophagus and the fundus of the stomach, but he believed that the majority of these patients required operative treatment.

E. D. D. Davis said that during twenty-five years he had œsophagoscoped more than 50 cases of so-called cardiospasm, but he had records of 36 only, and out of these he was able to show to the meeting a few X-ray photographs. They illustrated the intricate mechanism of the cardiac end of the œsophagus. There was a definite constriction as the opaque medium went through the diaphragm at the hiatus and the gullet bent forwards to the left. Often the œsophagus at the hiatus was mistaken for the cardiac sphincter. There was a good specimen at the Royal College of Surgeons showing the projection of the lower end of the œsophagus into the stomach. That was not shown in the ordinary post-mortem examination because the œsophagus and stomach were pulled out. He believed that dilatation in the œsophagus and the so-called cardiospasm and achalasia were a congenital neuromuscular disorder of the œsophagus. He had dilated with a bougie and had found a great variation in the ability to swallow. For months the patients would be perfectly well, and then they would have difficulty in swallowing and ask to be dilated. One man, aged 74, had had difficulty in swallowing all his life. The youngest case he had was a child of 10 years, but the condition had been seen in children under 4. He believed that Parkes Weber had collected eleven cases under the age of 7. In some cases the mercury tube was of no value, and he agreed with Sir James Walton that the proper procedure then was to open the stomach and dilate the cardiac sphincter, the earlier the better.

P. R. Allison said that one of the great difficulties in investigating the question of pressures in the œsophagus was that as soon as the œsophagoscope was passed the pharyngeal sphincter was opened and all the observations were null and void. But if after operation on the œsophagus for a carcinoma the upper end of it were brought out of the chest wall, an admirable opportunity was afforded for measuring the sort of pressures which were obtained on swallowing. To illustrate the force of swallowing he mentioned the case of one patient from whom he had removed the œsophagus, afterwards placing him flat on the table, putting in a tube and connecting it with a vertical glass tube. At the first swallow of water the patient pushed the water in the glass tube up to 12 in., and maintained it there; at the second swallow he pushed it up to 24 in., and still there was no regurgitation. At the third swallow it went up another 6 in. and then regurgitation occurred. Therefore by the force of swallowing alone a column of water  $2\frac{1}{2}$  ft. could be maintained. It was quite easy to see why a man could swallow while standing on his head, without peristalsis and without gravity. When a plastic operation was done the terrific pressure involved during the act of deglutition was demonstrable.

A. S. Johnstone showed some radiograms illustrating the mechanism of swallowing to explain an unusual cause of dysphagia. The barium meal in its passage was observed and the overturning of the epiglottis clearly illustrated. His explanation was that the hyoid bone was raised upwards and forwards and the thyroid cartilage came well up into it. This caused the pad of fat at the base of the epiglottis to bulge backwards to meet the closing arytenoids. A fulcrum was made at this point and the base of the tongue rolled the base of the epiglottis over. The rest of the movement was carried on by the small intrinsic muscles. If several swallows were made without respiratory interruption the epiglottis remained overturned. When the act was completed the hyoid bone and thyroid cartilage dropped back and the base of the epiglottis returned to its normal position, the tip sliding up the posterior pharyngeal wall to flick back into the upright position. The restoration was completed by the recoil of the elastic tissue. In a number of cases the return of the epiglottis was so slow that it caused the sensation of something sticking in the throat. This occurred generally in elderly patients and was probably due to senescence in the elastic cartilage. These were the individuals who might develop cancer-phobia, complaining of something sticking in their throat and constantly seeking advice. Only to be told that there was nothing abnormal.

Walter Howarth said he was quite sure there was no real cardiac sphincter. He had made many dissections of the lower end of the œsophagus with the late Professor Shattock, and it was quite impossible to prove the existence of any anatomical sphincter.

J. C. Hogg said the point with regard to the treatment of cardiospasm or achalasia was that all the various procedures would do good in the appropriate case. Some cases would respond easily, others would require more radical treatment. No mention had been made so far of dilatation with the hydrostatic bag as a favourable method in this condition. Sir James Walton took the view that it was dangerous to use a form of instrumental dilatation. With the greatest respect he joined issue with him on that point. To his own way of thinking there was as much precision in dilatation with a rubber bag filled with water or air as with the finger. He could not admit that the risk of rupture of the œsophagus was any greater—indeed he would consider it was less—with the bag than with the fingers. There might be severe cases which did not respond to that treatment, but he was satisfied that the average severe case would do so.

## Section of Epidemiology and State Medicine

President—E. H. R. HARRIES, M.D.

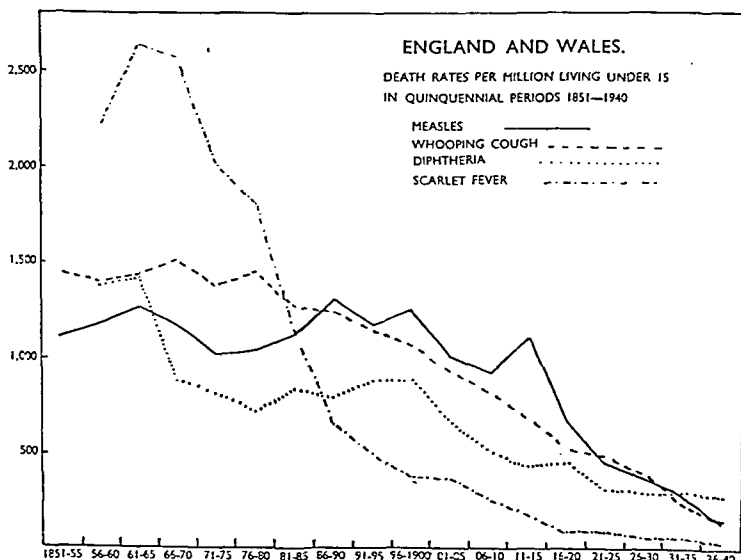
[November 27, 1942]

### Variations in the Mortality and Incidence of the Common Infectious Diseases of Childhood over a Century

By A. H. GALE, D.M.

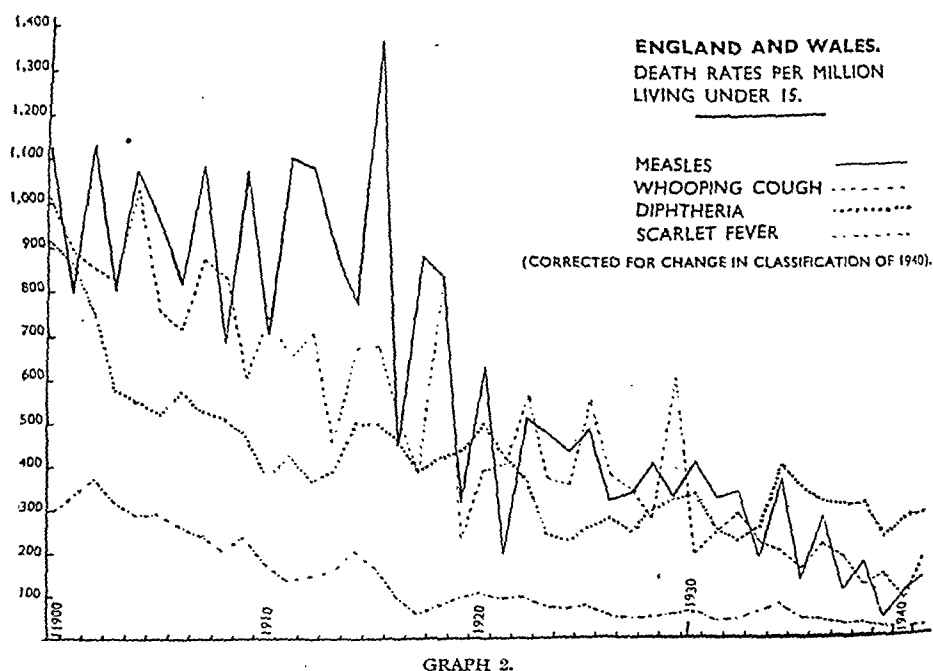
I BEGIN my story with a study of mortality, because we have mortality statistics of England and Wales for a much longer period than we have statistics of incidence. Mortality statistics are available for all four diseases—diphtheria, scarlet fever, measles and whooping-cough—for nearly a century, whereas general incidence figures for diphtheria and scarlet fever date from 1911 and those of measles and whooping-cough only from November 1939. In presenting the figures I have constructed graphs from the figures in the Annual Reviews and Quarterly and Weekly Returns of the Registrar-General. I have followed the same general plan throughout, first showing a long-term view of mortality or incidence followed by short-term views of particularly interesting periods.

My first graph comes from Professor Greenwood (1935) though I actually constructed



GRAPH 1.

my version from Table 9 of the Registrar-General's Review (Tables) for 1938 with additions for the years 1939-40. It shows death-rates of the four diseases, per million children living under 15 years of age, in five-year periods, from the quinquennium 1856-60 to that of 1936-40. Perhaps the most striking feature is the well-known enormous reduction in scarlet fever mortality. This disease caused some 2,500 deaths per million children under 15 at the beginning of the period and only about 20 per million at the end of it. Miss Woods (1933) in her study of the epidemiology of scarlet fever thought that there were indications about 1933 that scarlet fever might be changing type again, but so far this does not seem to have happened and the slight rise in mortality of 1933-34 has been followed by a fall to new low records. Though the behaviour of scarlet fever is the most dramatic feature, the other three diseases have shown very substantial reductions, particularly in the measles mortality which had ups and downs till about 1915 and has since been going down rapidly.



Graph 2 shows death-rates from 1900 to 1941. The rates have been corrected in accordance with the revised classification of deaths adopted in 1940, though this does not make a very great difference when we are studying trends. The rates for 1940 and 1941 have been calculated on mid-1939 population estimates. This graph shows the violent short-term fluctuations of measles and whooping-cough and the longer-term fluctuations of diphtheria and scarlet fever. It is a little difficult to disentangle trends when annual fluctuations are so great, but the years of the last war are something of a landmark in the history of the mortality of these diseases. Measles is the best example, for after the great conflagration of 1915, with its death-rate of 1,370 per million living under 15 years old, it exceeded the 600 mark in only three years—1917, 1918, 1920. Whooping-cough had a death-rate of 854 per million under 15 in 1918, which was of course a remarkable year for other reasons, and only once since then—in 1929—has it exceeded 600. Diphtheria shows a rapid fall beginning in 1921 but rises again, though not to the 500-600 level common in the early years of the century. Scarlet fever mortality fell particularly rapidly from 1915-18. These reductions may possibly be connected with the fall in the birth-rate. This had been falling slowly since the peak of the decennium 1871-80 when the mean annual rate per 1,000 of population was 35.4, but the fall was greatly accelerated in the war years and after: See Table I given in the recent white paper on the Current Trend of Population in Great Britain. I use this rather than a table of birth-rates because

TABLE I.—AVERAGE ANNUAL INCREASE IN POPULATION—GREAT BRITAIN.

Period	Numbers in thousands	Per cent.
1871-81	364	1.30
1881-91	332	1.06
1891-01	397	1.13
1901-11	383	0.98
1911-21	194	0.46
1921-31	203	0.46
1931-38	201	0.44

the birth-rate was very unstable for some years after the war. This table gives figures for Great Britain and not for England and Wales, but this fact does not make it any less interesting. For the period 1911-1921 the average annual percentage increase of the population was less than half of what it had been in the period 1901-11. A relatively sudden fall of fatality during or soon after the last war appears in some of the later graphs.

TABLE II.—DEATHS IN EACH QUARTER 1938-1942 IN ENGLAND AND WALES.

			1938	1939	1940	1941	1942
Diphtheria :	1st quarter	...	970	708	584	849	635
	2nd "	...	652	434	411	627	
	3rd "	...	564	426	579	507	
	4th "	...	674	564	906	658	
Scarlet fever :	1st quarter	...	121	49	51	49	16
	2nd "	...	79	51	32	28	
	3rd "	...	55	40	33	31	
	4th "	...	57	41	38	25	
Measles :	1st quarter	...	822	87	152	643	52
	2nd "	...	562	99	140	399	
	3rd "	...	88	62	171	78	
	4th "	...	52	54	394	25	
Whooping-cough :	1st quarter	...	407	426	175	794	252
	2nd "	...	308	418	107	761	
	3rd "	...	152	247	121	569	
	4th "	...	184	138	275	259	

Table II shows the actual number of deaths in each quarter from 1938 to the first quarter of 1942 and covering the period of the great dispersal. On the whole deaths were low in the last quarter of 1939 and the first of 1940, as compared with the corresponding quarters of other years. It is strange that scarlet fever deaths have continued to fall though the other diseases have to some extent resumed their normal habit.

Graph 3 gives a comparison of death-rates from diphtheria in England and Wales and in the United States (registration states of 1900). The curves are on a logarithmic scale and that for the United States has been adapted from Geddes Smith (1941). The U.S. figures are rates per hundred thousand total population and those for England and Wales are rates per million children under 15. It is therefore possible to compare only the general trend. The scale too is a little different though the time scale is the same. The curve for diphtheria falls like a stone in recent years in the United States figures and remains fairly constant in ours. Similar curves for the other three diseases, which are

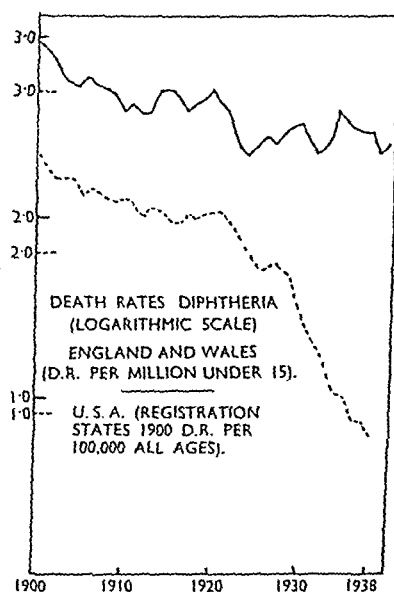
TABLE III.—RECENT CRUDE DEATH-RATES IN ENGLAND AND WALES AND IN U.S.A. (32 STATES)—PER 100,000 TOTAL POPULATION.

			1937	1938	1939	1940	1941
Diphtheria :	E. and W.	...	7.2	7.1	5.1	6.0	6.4
	U.S.A.	...	1.8	1.7	1.3	0.9	0.7
Scarlet fever :	E. and W.	...	0.9	0.9	0.4	0.4	0.3
	U.S.A.	...	1.4	0.9	0.7	0.5	0.4
Measles :	E. and W.	...	2.6	4.0	0.7	2.1	2.8
	U.S.A.	...	0.9	2.3	0.7	0.3	1.6
Whooping-cough :	E. and W.	...	4.3	2.7	3.0	1.6	5.7
	U.S.A.	...	3.4	3.2	2.1	1.9	2.5

omitted to economize space, show a similar trend in both countries though the post-war fall begins a little later in the United States. To bring the story up to date Table III

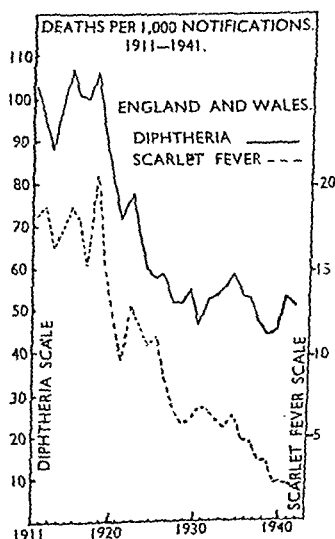
gives recent crude death-rates in England and Wales and in an aggregate of 32 States of the United States. (Ministry of Health Report and U.S. Public Health Report.)

There are obviously two things which may account for a true fall in the death-rate

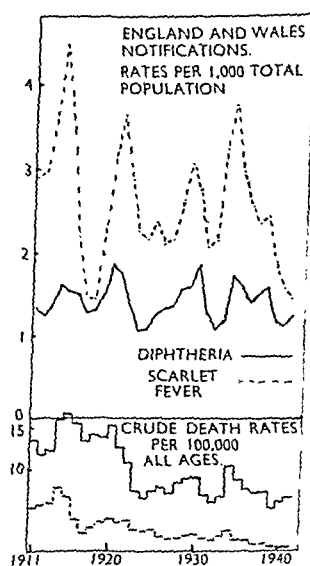


GRAPH 3.—Trend of diphtheria death rates in England and Wales and in U.S.A. (U.S. curve from "Plague on Us.").

of a disease. Either it may become less fatal, or less common, or both. Graph 4 shows the deaths per 1,000 notifications from diphtheria and scarlet fever from 1911 to 1941. Diphtheria shows a substantial fall beginning in 1919 but ending in 1927, and scarlet fever a fall which began in 1919 and which has continued with only two small setbacks.



GRAPH 4.

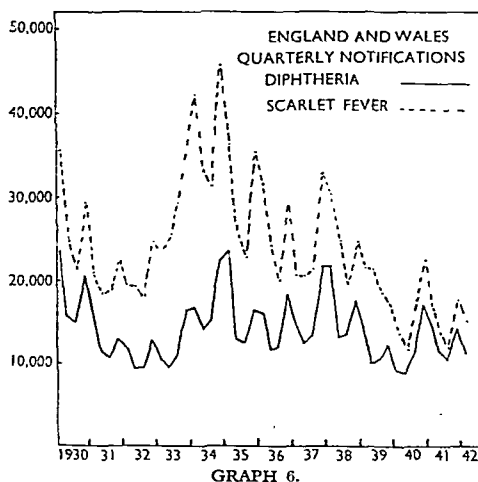


GRAPH 5.

Both these and the following graph of incidence depend on the notifications of many different doctors and extend over a period of thirty years in which the generally accepted criteria of diagnosis may possibly have changed to some extent, but I do not think that these difficulties upset the general conclusion that the fatality of both diseases, particularly that of scarlet fever, has decreased considerably. It is of course possible to give a long-term view of case fatality only for diphtheria and scarlet fever and the same applies to incidence with which the next graph (5) is principally concerned. This shows the notification rates for diphtheria and scarlet fever per 1,000 of the total population from 1911 to 1941. I have also included crude death-rates per 100,000 of total population in order to relate mortality and incidence to some extent. There does not seem to have been any definite reduction in incidence over the thirty years, which have seen an appreciable reduction in mortality from diphtheria and a substantial reduction in that of scarlet fever.

Graph 6 is a larger scale view of quarterly notifications from 1930 to 1942, first quarter. It shows their usual seasonal incidence and their unusual behaviour in the last quarter of 1939 and the first quarter of 1940. The usual last quarter rise in notifications of scarlet fever was entirely absent in 1939 and that of diphtheria was very slight. Graphs of weekly notifications for the period before, during and after dispersal show the low incidence during dispersal and the falls of notifications associated with school holidays.

That great epidemiologist Shirley Murphy (1907) in a characteristically modest paper compared the number of cases of scarlet fever and diphtheria which actually occurred in the month of August during the ten years, 1895-1904, with the number which



would have occurred had the schools not been closed. The estimate was based on an average of notifications for June and July, and September and October. He found a deficit of 27.6% for scarlet fever and 23.3% for diphtheria. Shirley Murphy of course considered the obvious criticisms—that the population exposed to risk might be smaller in August, that notifications were more incomplete, &c.—but concluded that the main factor was reduced opportunity of transmitting infective material.

Dispersal really began with the summer holiday at the beginning of August 1939, but the evacuation movements did not, of course, take place until a month later. The effect on diphtheria and scarlet fever has been described in detail by Stocks (1941) in a paper in which he analyses the behaviour of the two diseases in evacuation, neutral and reception areas. He has shown that the rise of incidence which was expected to occur in the reception areas as a result of the influx of town children did occur to some extent, but was entirely obscured in the national statistics by the considerable reduction in incidence in the evacuation areas.

It is very difficult to make up one's mind exactly how far the reductions in incidence of infectious disease were due to removal of children from the thickly populated evacuation



towns with consequent "thinning" of the child population and how far they were due to school closure. If one tries to reduce the movements of child population and the re-opening of schools to terms of numbers one becomes lost in a maze of figures. Those evacuation areas from which few children went out appeared to share in the reduction experienced by the more heavily evacuated areas. I believe that school closure was a considerably more important factor than "thinning".

**Public air-raid shelters.**—Anyone who visited a large public shelter on a "full" night almost inevitably came away with the impression that a very large proportion of the population of London was inside. Actually the proportion of the population of the metropolitan boroughs sleeping in public shelters never exceeded 9% even at the height of the attack (Cmd. 6340). So far as the children's diseases are concerned I am very doubtful whether the public air-raid shelters had any epidemiological effect at all. If children had been concentrated in large numbers in a few shelters instead of being scattered throughout many the result might have been different.

The points of particular interest can be divided into theoretical and practical.

The first theoretical one is the possible association of the sudden acceleration of the fall in mortality of children's diseases which occurred during or just after the last war with the sudden acceleration in the fall of the birth-rate which occurred at about the same time. In the case of the human herd this is divisible into two components. There is first the factor of the reduction in the number of susceptibles added to the herd every year, and secondly the environmental factor. A fall in the birth-rate means a smaller family with, as a result, improved social conditions for the children—more food, less overcrowding, more parental care. The fall of mortality is perhaps rather indefinite in some diseases, but it does seem to me that there was a relatively sudden step down superimposed on the slow fall which was taking place all the while. There is also the possibility of the fall being apparent rather than real and being due to the altered age constitution of the child population—particularly in the case of diseases like whooping-cough and measles which kill young children rather than older ones. A calculation of the measles death-rate for children aged 0-5 over this crucial period might throw light on this aspect. This brings me on to my second point concerned with the incidence of diphtheria and scarlet fever. I can see no appreciable reduction of notification rates in the general population in the period 1911-1939 and yet the proportion of children, who produce most of the cases, has fallen considerably. In 1911 there were about 306,000 children under 15 per million of the population of England and Wales and in 1939 about 211,000.

Of practical points, the first concerns diphtheria and the second school closure. Diphtheria killed no fewer than 2,480 people in England and Wales in 1940. Much has been done in the United States and Canada but I will content myself with a less remote example. In Scotland up to June 30, 1942, approximately 73% of the school and 58% of the pre-school population had been immunized.

TABLE IV.—DIPHTHERIA DEATHS IN SCOTLAND (16 PRINCIPAL TOWNS).

		1940	1941	1942
First quarter	...	108	128	74
Second "	...	89	67	37
Third "	...	115	48	28
Fourth "	...	152	91	

(From B.M.J., Epidemiology section.)

Table IV shows the deaths from diphtheria in each quarter from 1940 to the third quarter of 1942 and does I think suggest that the immunization campaign may already be meeting with success.

On the question of school closure it seems clear that closing all the schools does reduce the incidence of infectious disease. But school closure in face of an epidemic usually means closure of one or two schools in which the disease has appeared. I doubt if dispersal gives us any information one way or the other on the soundness of such a procedure. Closure of all the schools over a large area would be, to put it mildly, a highly inconvenient procedure and the graphs of weekly notifications suggest that, unless the period was long enough to extend into the non-epidemic season, the epidemic would start soon after the re-opening. I do not think therefore that the experience of the dispersal upsets the policy which we have been advocating for years of keeping a school open in face of an epidemic. We should, however, consider the matter of infection-spread seriously when the question of post-war design of schools arises. I have wanted to investigate the incidence of infectious disease in open-air schools, but have been deterred by the obvious difficulties of devising

a control. In Professor Topley's (1942) Croonian lectures, some of his remarks about the experience of dispersal are very relevant to this question of the school as a source of infection.

My story began in the years of abounding fertility—the climax of the industrial revolution—when the birth-rate was about 35 per 1,000; it extends through one great war to the middle of a second—years of uncertainty and until recently of a falling birth-rate. These common infectious diseases which used to kill so many have lost much of their deadliness and seem still to be retreating, but one can never tell with epidemic diseases. We know how important are social conditions in determining mortality from these diseases and I suggest that it is a small but important by-way of social history which I have tried to outline.

Finally I should like to acknowledge the help which I have received from Dr. Glover, Dr. Percy Stocks and Professor Greenwood. Professor Greenwood has kindly given advice on the preparation of the paper for publication.

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Professor M. GREENWOOD said that the inferences the author drew from the evidence in his excellent paper seemed to be correct, and Dr. Gale had rightly said that the periodicity of measles was a complex problem. Two elements must be distinguished. The first had long been recognized vaguely and was expressed with quantitative precision by the late Sir William Hamer and, still more precisely, by the late H. E. Soper. If in an epidemic the susceptible population was largely depleted and was then continuously built up by accessions, *per vias naturales*, of newcomers, a periodicity was inevitable and these writers have defined the rhythm precisely. But, as Soper pointed out, this mechanism while accounting for a good deal did not account for everything. The late Dr. John Brownlee's method of approach was wholly different and although his biological interpretation of the facts was hard to follow it was equally hard to resist his evidence that something more subtle than an ebb and flow of susceptibles was involved.

The effect of school closure on morbidity or mortality would depend—if analogy with experimental epidemiology held—largely on the point in time when closure was effected. If before an epidemic movement began, or very early in the cycle, there was closure, the result would be good; but it would not be good later, when the wave had gathered head.

Dr. J. ALISON GLOVER said that of all the phenomena described by Dr. Gale, the decline in the severity of scarlet fever was the most interesting. The case fatality of this disease in England was now probably less than one-fiftieth of what it was in 1876. This extraordinary change had occurred in the speaker's lifetime. Galabin (Galabin, A. L., 1902, *Lancet*, i, 1671) and others long ago showed that the trend and oscillations of mortality from rheumatic fever closely corresponded with those of scarlet fever, and rheumatic fever mortality had also sunk to new low records. There was general agreement that cases of rheumatic fever and chorea in children were now much less common than even before the present war. The decline of another disease, also a "poverty" disease and also associated with hæmolytic streptococcal infection, i.e. chronic otitis media, was also continuous. Its incidence in London school children was now about one-twelfth of what it was thirty years ago. This was a cognate phenomenon. While Dr. Gale had shown that these falls in the mortality from the common infectious diseases of childhood began long years ago, he had also shown their continuance and indeed acceleration since the war began, despite the vicissitudes of the times, the three

severe winters, much shifting of population and shelter life. This comparative immunity seemed to give strong support to the view that, so far, the health of our school children had not deteriorated. We owed much to our public health services, to increased prosperity among those classes in whom mortality from these diseases usually occurred and much to an enlightened food policy backed by the efforts of our sailors, farmers and Allies to feed us.

Dr. M. MITMAN noticed from Dr. Gale's tables that there had been a decline in the incidence of measles in the U.S.A. corresponding in time to the period (1939-40) when the expected epidemic of measles failed to materialize in this country. Presumably the reasons given for the decline here—evacuation and dispersal—were not operative there. Some better explanation than that usually given was necessary to account for the periodicity of measles and he suggested that the age of the disease and the level of natural immunity of the herd might be factors. He contrasted the behaviour of endemic diseases which were constantly present in the population with measles which disappeared for intervals, and asked where the reservoir of the virus might be.

THE PRESIDENT claimed for the clinicians some part in the reduction of case-fatality rates and, therefore, of death-rates from the common fevers. The use of diphtheria antitoxin in this country from 1895 onwards had been a main, but not the only, factor in the reduction of fatality from that disease. During recent years the injection of improved antitoxin in more adequate doses had secured better results. Dr. Harries had alluded to the great decline in the incidence of laryngeal diphtheria during the last few years and to the curious and unexplained association of the *mitis* strain of the *C. diphtheriae* with this most fatal form of the disease among young children. Decline in the fatality of scarlet fever had commenced before hospitalization and at the time of the introduction of scarlet fever antitoxin, about 1925, had fallen so low as to make any claim to a further reduction of fatality from its use of very dubious value. Scarlet fever antitoxin had reduced the incidence of those complications not due to sepsis and had facilitated a shortened stay of patients in hospital.

Measles and whooping-cough proved so fatal among young children because of the complication of bronchopneumonia. There was no doubt at all that fatalities from this complication had been very greatly reduced by the use of the sulphonamides and oxygen tents.

Dr. ROBERT SWYER said that of 1,200 cases of measles treated at North Eastern Hospital during the 1940-41 epidemic, 40% had been sleeping in public shelters. In a small controlled series of cases of bronchopneumonia complicating measles treated with sulphapyridine he found that: (i) the duration of pyrexia was reduced by 20% in the drug-treated cases; (ii) the tachypnoea was greater and persisted longer in the control cases; and (iii) the case mortality rate was roughly halved in the sulphapyridine-treated cases.

The mortality from bronchopneumonia in these 1,200 cases was 0.75%.

## Section of Obstetrics and Gynæcology

President—Dame LOUISE McILROY, D.B.E., M.D.

[November 20, 1942]

### DISCUSSION ON NEW DEVELOPMENTS IN THE INVESTIGATION AND TREATMENT OF STERILITY

**Mr. V. B. Green-Armytage:** To-day sterility is the commonest single cause of attendance at gynæcological out-patients. Though 12-14% of modern women are said to be congenitally sterile, it is to the development of the uterus and endocrines, and/or the condition of the cervix that we must look if we are to help most of the cases of primary infertility that confront us.

In order to clarify this matter two groups each of twenty healthy young married women were chosen for investigation and watched over a period of two years.

#### GROUP I.

All were examined within two weeks of marriage and persuaded to live an absolutely normal sex life.

In 5 the uterus (and presumably the ovaries) at first examination was normal in size and shape. They rapidly conceived.

In 15 the uterus (and ovaries) were palpably small and immature.

In 9 of these the uterus grew to normal size in four and a half to six months. Conception occurred after an average of seven and a half months of married life.

In 1 uterine development was partial or delayed for just over twelve months.

In 3 it was delayed beyond the period selected for observation, but in 2 of these the husband was at fault.

In 2 maturation never in the least occurred: the so-called Peter Pan uterus.

#### GROUP II.

Consisted of 20 young women who from the very beginning of married life made use of chemical douches or caps with medicated pessaries or they stated that their husbands used condoms or adopted coitus interruptus.

These were first examined after a period of one to two years.

In 4 (possibly 5) full maturation of the uterus had occurred.

In 10 the uterus was palpably small and hypoplastic. Prolonged continuance of such contraceptive practices may determine future sterility.

In 5 there was a small annular erosion around the external os. At the ovulation period, in these, the cervical mucus plug was viscid, opaque and infected—a mechanical barrier.

What are the causes of the rapid maturation of the uterus in Group I? What is the reason of the deficient or retarded growth in Group II? As hitherto it has been supposed that folliculin and prolan A were responsible for uterine and ovarian maturity, it was decided to carry out certain animal experiments in the Pearson Foundation Research Laboratory under the direction of Professor Silberstein at the West London Hospital. Preliminary experiments indicate that full development of the female genitalia is due to the absorption of hormones by the vagina from the human semen, and that this hormone is probably testosterone or a hormone allied to it as was premised by R. L. Noble in 1939. To prove this a number of immature female rats of the same litters were spayed, and then using one as a control every alternate rat was injected intramuscularly over a period of three weeks with 0.5 c.c. of human semen—7 or 8 injections in all being given.

Fig. 1 shows marked hypertrophy of the uterus in the injected rat. Fig. 2 shows high and low magnification photomicrographs of the control uterus as compared with that of an immature injected rat. Note the cellular and glandular hyperplasia together with marked muscle growth. Fig. 3 is the uterus of a small non-spayed immature rabbit: 1 c.c. human semen diluted in 3 c.c. saline was given intravenously three days running, and it

was killed twenty-four hours after the last injection. Note gross hypertrophy and "blut punkte" in left ovary. Fig. 4 is a section of ovary from the same rabbit.

Until experiments are made upon hypophysectomized animals one cannot definitely state that the hormone of human semen after absorption acts through the anterior pituitary, but it would seem, so far, most probable that in normal circumstances the testosterone is converted in the body into some other compound which has oestrogenic and even follicle stimulating properties.

Whatever the ultimate biochemical compound these experiments do show that the semen of *homo sapiens* possesses a hormone of tremendous importance to the virginal genital tract, and from an applied gynaecological aspect, particularly to that tract in the early months, or even years, of matrimony. *The deduction being that any thing or any method which prevents, retards or alters the normal degree of physiological absorption of human semen from the vagina carries with it during the early months and years of marriage the risk of future sterility from failure of uterine development and endocrinal asynchronization.* I need not here stress the serious implication of this work in relation to the birth-rate.

It is just possible while seeing on the screen the results of our experiments that the idea may have crossed the minds of some of my audience that small doses of testosterone might be useful in the case of the sterile woman. I have no experience of its value in this direction, but if experiments now in process show that luteinization is not inhibited then a new field for clinical observation and report would seem to be open.

Until recently most cases of hypoplasia have been treated with thyroid and stilbæstrol, and, more recently, pregnant mares' serum (gestyl), to activate the hypophysis or ovary—usually without any resultant development. In some of these cases the condition would seem irretrievable, for the tubes are long and tortuous and menstrual function is absent or agley, yet I have known pregnancy to occur in several such patients subsequent to "small dose" X-ray therapy and obedience to rules which will be indicated later.

Slides were shown of a case where amenorrhœa had existed for sixteen months, demonstrating a small uterus and enormous length of the tenuous tubes. (Not illustrated.) Exhaustive endocrine treatment, short-wave therapy, &c., had utterly failed, yet after 9 applications of X-rays at one-week intervals, a period returned and she conceived during the next ovulation period and went to term. Slides were also shown of a similar case in a woman weighing 16 st. Her periods were most irregular and for over ten years had lasted less than a day. After 12 applications of X-rays she had four menstrual periods lasting five to seven days and then conceived. She is now four months' pregnant.

Mr. Carter Braine has treated twelve such sterility patients for me. Four have become pregnant—three have been confined of perfectly normal children and one expects in five months' time. It is, I believe, the opinion of radiologists that X-rays in these patients neutralize some inhibitory factor rather than stimulate the ovaries and pituitary.

There is an erroneous idea that tubal occlusion is a common cause of sterility. From the routine performance of well over 2,000 utero salpingograms for the investigation of sterility I can say that this is not so. My statistical findings which are very closely in line with those of Samuel Meaker show that in not more than 14% of primary sterility cases are the tubes occluded. It must be realized too that salpingography, properly done, has, from the point of view of treating sterility, a higher therapeutic value than Rubin's insufflation test—a matter of economic and practical importance to-day. Whether the iodized oil stimulates the ovary or tubo-uterine mucous membrane, I am not prepared to say, but the fact remains that over 40% of such cases very shortly afterwards become pregnant.

#### CERVIX.

The secretory cells of the endocervix vary according to the ovulation or oestrogen cycle, that is, just as there is an endometrial cycle so there is a cervical one. Moreover, Novak has shown recently that there is also a corresponding tubal cycle. These facts are important, for whereas the secretion of the cervical canal is for most of the month thick, viscid and opaque, at the time of ovulation (perhaps three to five days in all) (and also for a short space in the premenstruum corresponding with the second oestrogen rise) the secretion is thin, glairy and translucent. Still more important at this essential time are other remarkable cervical features: (1) the pH reaches an average of 8.5; (2) it becomes rich in mucin and glycogen; and (3) the temperature of the canal itself rises above normal. Can it be doubted that the object of all these changes is but to assist sperm migration? Again and again with platinum loop or small spoon I have taken a specimen of cervical secretion for nitrazine test and microscopic examination. In some I was doing a Hühner's test, that is looking for live sperms in the cervical canal. In others a routine experimental test was being performed in women who had or had not previously used contraceptives.

PLATE I.



FIG. 1.—Uterus of two immature rats, one (I) injected with 0.5 c.c. human semen for 3½ weeks, showing growth and elongation of injected rat as compared with C (Control).

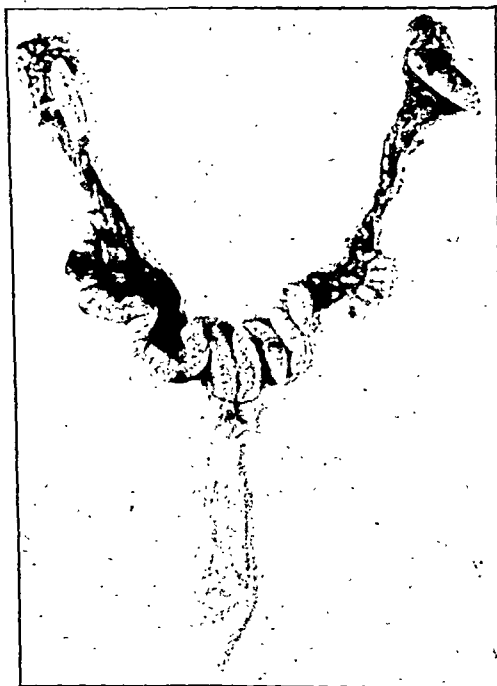


FIG. 3.—Uterus of immature rabbit which received on 3 consecutive days 1 c.c. human semen diluted in 3 c.c. saline. Killed 24 hours later, showing gross hypertrophy and "blut punkte" in left ovary.



FIG. 4.—Photomicrograph of left ovary of same immature rabbit ( $\times 200$ ) showing ++ follicle ripening and ovum. Observe granulosa layer hypertrophy.

V. B. GREEN-ARMYTAGH:

*Discussion on New Developments in the Investigation and Treatment of Sterility.*

was killed twenty-four hours after the last injection. Note gross hypertrophy and "blut punkte" in left ovary. Fig. 4 is a section of ovary from the same rabbit.

Until experiments are made upon hypophysectomized animals one cannot definitely state that the hormone of human semen after absorption acts through the anterior pituitary, but it would seem, so far, most probable that in normal circumstances the testosterone is converted in the body into some other compound which has oestrogenic and even follicle stimulating properties.

Whatever the ultimate biochemical compound these experiments do show that the semen of *homo sapiens* possesses a hormone of tremendous importance to the virginal genital tract, and from an applied gynaecological aspect, particularly to that tract in the early months, or even years, of matrimony. *The deduction being that any thing or any method which prevents, retards or alters the normal degree of physiological absorption of human semen from the vagina carries with it during the early months and years of marriage the risk of future sterility from failure of uterine development and endocrinal asynchronization.* I need not here stress the serious implication of this work in relation to the birth-rate.

It is just possible while seeing on the screen the results of our experiments that the idea may have crossed the minds of some of my audience that small doses of testosterone might be useful in the case of the sterile woman. I have no experience of its value in this direction, but if experiments now in process show that luteinization is not inhibited then a new field for clinical observation and report would seem to be open.

Until recently most cases of hypoplasia have been treated with thyroid and stilbæstrol, and, more recently, pregnant mares' serum (gestyl), to activate the hypophysis or ovary—usually without any resultant development. In some of these cases the condition would seem irretrievable, for the tubes are long and tortuous and menstrual function is absent or agley, yet I have known pregnancy to occur in several such patients subsequent to "small dose" X-ray therapy and obedience to rules which will be indicated later.

Slides were shown of a case where amenorrhœa had existed for sixteen months, demonstrating a small uterus and enormous length of the tenuous tubes. (Not illustrated.) Exhaustive endocrine treatment, short-wave therapy, &c., had utterly failed, yet after 9 applications of X-rays at one-week intervals, a period returned and she conceived during the next ovulation period and went to term. Slides were also shown of a similar case in a woman weighing 16 st. Her periods were most irregular and for over ten years had lasted less than a day. After 12 applications of X-rays she had four menstrual periods lasting five to seven days and then conceived. She is now four months' pregnant.

Mr. Carter Braine has treated twelve such sterility patients for me. Four have become pregnant—three have been confined of perfectly normal children and one expects in five months' time. It is, I believe, the opinion of radiologists that X-rays in these patients neutralize some inhibitory factor rather than stimulate the ovaries and pituitary.

There is an erroneous idea that tubal occlusion is a common cause of sterility. From the routine performance of well over 2,000 utero salpingograms for the investigation of sterility I can say that this is not so. My statistical findings which are very closely in line with those of Samuel Meaker show that in not more than 14% of primary sterility cases are the tubes occluded. It must be realized too that salpingography, properly done, has, from the point of view of treating sterility, a higher therapeutic value than Rubin's insufflation test—a matter of economic and practical importance to-day. Whether the iodized oil stimulates the ovary or tubo-uterine mucous membrane, I am not prepared to say, but the fact remains that over 40% of such cases very shortly afterwards become pregnant.

#### CERVIX.

The secretory cells of the endocervix vary according to the ovulation or oestrogen cycle, that is, just as there is an endometrial cycle so there is a cervical one. Moreover, Novak has shown recently that there is also a corresponding tubal cycle. These facts are important, for whereas the secretion of the cervical canal is for most of the month thick, viscid and opaque, at the time of ovulation (perhaps three to five days in all) (and also for a short space in the premenstruum corresponding with the second oestrogen rise) the secretion is thin, glairy and translucent. Still more important at this essential time are other remarkable cervical features: (1) the pH reaches an average of 8.5; (2) it becomes rich in mucin and glycogen; and (3) the temperature of the canal itself rises above normal. Can it be doubted that the object of all these changes is but to assist sperm migration? Again and again with platinum loop or small spoon I have taken a specimen of cervical secretion for nitrazine test and microscopic examination. In some I was doing a Huhner's test, that is looking for live sperms in the cervical canal. In others a routine experimental test was being performed in women who had or had not previously used contraceptives.

If at the mid-cycle the mucus is crystal clear then from the point of view of sterility the prognosis is good, and if in such a one, a Huhner's test is done it is usual to see a few motile sperms per field. On the other hand in cases of sterility it is far more usual to find at the ovulation period that the mucus is unduly sticky and opaque, the result of low-grade infection, *chemical contraceptive irritants* or the congestion associated with repeated coitus interruptus—the opacity of course being due to debris and leucocytes. In such a case no spermatozoa will be found, for the invasive or mucolytic capacity of the sperm is inhibited either by the infected plug or by the diminished pH of the secretion. This type of case is most common, for the sterility is due to an ill-conditioned secretion which acts as a mechanical obstruction. In some women nature can and often does get over this difficulty by the physical means of orgasm, a condition which results in a sudden outpouring of a highly alkaline thin fluid that washes away the viscid plug, its place being taken by a clear but permeable secretion. In others, however, despite orgasm the condition continues. It can be demonstrated by Schiller's test, for in many there is a strawberry erosion which is the outward and visible sign of endocervicitis. These are the cases that frequently become pregnant three or six months after dilatation, insufflation and electrocauterization of the cervix, combined with a course of thyroid and stilboestrol.

From time to time one meets with cases where every known treatment fails to get the cervical canal healthy, the mucus plug remaining viscid, opaque, yellow and infected. Occasionally gratifying results are obtained from a regular three months' course of thyroid, with hexoestrol  $\frac{1}{2}$ -1 mg. given for the first five days of the cycle; but should nothing succeed and all other investigations prove that both husband and wife are in every way normal, then artificial insemination should be advocated. The modern technique is not difficult and has with practice a success rate of 30-40%. All that is required is for the husband and wife to reside in an hotel or house fairly close to the surgeon's consulting room. The husband is requested to abstain from cohabitation for at least two weeks before the selected ovulation date, that is the 12th, 14th, and 16th days of a normal cycle. At 8-9 a.m. coitus interruptus should occur, the husband ejaculating into a sterile jar (a condom should on no account be used). Within a maximum of two hours the wife presents herself at the consulting room with the jar which should have been kept at room temperature and in no way heated. She is placed in the lithotomy position on a sandbag. A speculum being inserted, the os is exposed and cleansed. A quarter to half cubic centimetre of the semen (which liquefies within twenty minutes of emission) is then drawn up into a special pipette or syringe which is passed through the internal os and injected. It is important to see that no air goes in with the semen, for if so there will be instant contraction of the uterus and possible extrusion of the contents.

I have laid much stress upon the period of ovulation and rise in oestrogen level. My reason is that the statistics of Latz, Reiner, Pryde, Pugh, Smith and Williams which cover 65,300 uncontracepted acts (not followed by conception) which occurred during the so-called "safe" period, demonstrate without prejudice or doubt that not only is the time of ovulation the period of fertility, but also that the separate life of the sperm cell and ovum within the genital canal is less than forty-eight hours. Therefore in order to facilitate the early entrance of the spermatozoa into the very alkaline cervix, Dickinson has, I think, rightly stressed the importance of an optimum coital position in cases of sterility.

So far I have not mentioned the anovulatory patient, for extended personal experience and scores of biopsies seem to indicate that many women are anovulatory for a month or so in every year, and hence such women are only temporarily pathological. But should a patient constantly over a consecutive series of months show that there is no secretory phase, and there may be 5 to 10% of such women, then it will be advisable, and may be worth while, to give them 400-600 units of pregnant mare's serum between the 10th and 16th day of the cycle.

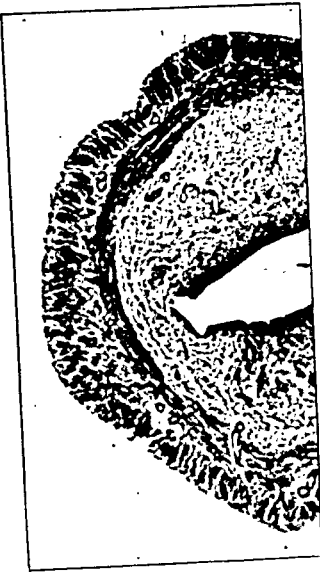
Finally, I should like to mention the value of amnioplastin at the time of doing salpingostomies. Wrapped round or shielding the distal ends of the surgically opened tubes it is certainly a surgical advance in technique which gives better results.

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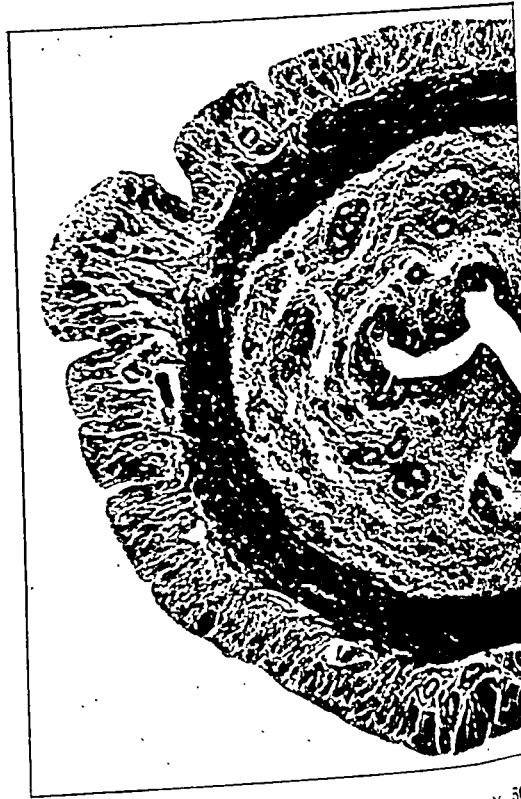
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PLATE II.



C.  $\times 50$ .



I.

FIG. 2.—Sections of the uterus of control (C) and injected (I) rats, showing progestational reaction and hypertrophy of the muscle in (I) after 7 injections of 0.5 c.c. human semen intramuscularly, as compared with control. (*Vide* Low and High Power Magnifications.)



C.  $\times 500$ .



I.

(Note High and Low Power Magnification of each.)

**Major Wittkower (Summary):** At the instigation of Professor Browne, some years ago, A. T. M. Wilson and I made an investigation of thirty sterile cases and a control group of thirty primigravidae corresponding in age. The sterility in all cases under examination had been primary. Production of active spermatozoa by the husband was known to have occurred. No other selecting principle existed. The starting point of our investigation was first, the complete absence of abnormal physical findings; secondly, the well-known fact that a certain personality type prevails amongst sterile women; and thirdly, the experience that sterile women frequently conceive under psychological treatment.

Both groups of patients were interrogated for at least two hours by an identical interview technique. The personality study covered the family background, and, in rather more detail, the childhood characteristics, the reaction to various phases of adolescence and adult life. Verbatim reports were kept of each interview.

**Childhood adjustment.**—Comparing both groups as children, psychologically well-adjusted types were found in great excess in the control group. Three in the control group of 30, in contrast to 14 out of 30 sterile patients, were definitely emotionally ill-adjusted.

**Table I:** As will be seen from Table I, a high proportion of the sterile patients, according to their account, were firstly, miserable non-aggressive; secondly, miserable ailing, or, thirdly exceptionally timid and shy as children.

TABLE I.—CHILDHOOD ADJUSTMENT IN CASES OF STERILITY.

	Control (30 cases)	Sterility (30 cases)
Apparently well-adjusted ... ..	19	9
Fairly well-adjusted (e.g. concealed shyness)	8	7
Definitely ill-adjusted—		
(a) Boisterous tomboy		
(b) Resentful, aggressive	2	3
(c) Miserable, non-aggressive		
(d) Miserable, ailing	1	11
(e) Exceptionally timid and shy		

**Childhood adjustment in relation to adult adjustment.**—**Table II:** Two of the three primigravidae, who had been ill-adjusted as children, made a fairly good adjustment in adult life, whereas the majority of the sterile patients continued to be ill-adjusted as adults, or, after previous good or fair adjustment, drifted into the camp of the ill-adjusted as they grew up. This may, of course, in part be due to their disorder; but it is also in keeping with the psychiatric experience that ill-adjustment in childhood frequently foreshadows ill-adjustment in adult life.

TABLE II.—ADULT PSYCHOLOGICAL ADJUSTMENT IN RELATION TO CHILDHOOD ADJUSTMENT.

Control group (30)		Sterility (30)	
As children.	As adults	As children	As adults
W W W W W W W W W W	0 W W W W	W W W W W W W W W W	0 Nil
W W W W W W W W W W	1 W W W W W W W W W W		1 W
W	F F		F
F F F F F F F F F F	2 W W W W W W W W	F F F F F F F F F F	2 W
	F F F F F F F F		F F F
	I I		I I I I
I I I	3 W	I I I I I I I I I I I I	3 W W W W W W
	I		F F F
	4 Nil		I I I I I I I I
			4 W
			I I

Children are classed above as "Well-adjusted" (W); "Fairly well-adjusted" (F); and "Definitely ill-adjusted" (I).

Adults are classified in increasing degrees of maladjustment as 0, 1, 2, 3, 4. For comparison, Classes 0 and 1 are grouped as "well-adjusted," 2 as "fairly well-adjusted," and 3 and 4 as "definitely ill-adjusted." In the "As adults" columns "W," "F," and "I" give the childhood adjustment in each adult.

**Adult sexuality.**—Omitting other aspects of the adult personality, some differences in sexual development were noted in the two groups under consideration. Firstly, in relation to instruction before onset of the period, a slight excess of unprepared girls could be found in the sterile group. Secondly, as regards the reaction of the patients to the onset of menstruation, it could be seen that the ratio of girls who are neutral to those who resented menstruation varied in both groups. The proportions were: control group—neutral 3, resentful 2; sterile group—neutral 1, resentful 1; and in an equal number of dysmenorrhœa patients—neutral 1, resentful 2.

**Table III:** Thirdly, in the control group the premarital attitude to "boy friends" showed two main types in equal frequency—girls who had several minor friendships before engagement and marriage, and girls who had not made any other than the most superficial

**Mr. Kenneth Walker:** The role of the male in infertile marriages is now generally recognized. The observations which I am about to make are not mine alone, but are those made by a group investigating this subject: Dr. Wiesner, Mr. Lane-Roberts, Dr. Mary Barton and myself.

We have learnt to pay less attention to the number of spermatozoa present in a sample of semen and more attention to their *morphology* and their *viability*. The degree of *uniformity* found in their head-lengths is also of great importance; great variations in head lengths are common amongst infertile men, and comparatively rare amongst the fertile. Even more important is the presence in the semen of abnormal and immature forms, for example, spermatids which have only undergone partial transformation into spermatozoa. These abnormalities are often associated with the presence in the semen of disintegrating testicular cells, particularly multinuclear and degenerating forms of spermatocytes and spermatids. Another sign of infertility is the rapid loss of motility of the spermatozoa actually present.

We employed testicular biopsy first in order to differentiate between cases of azoospermia due to a blockage in the ducts and those resulting from aspermatogenesis, and found that even when a blockage had existed for some time spermatozoa may continue to be produced in the testes. Charny has since confirmed these findings. Because a blockage is not necessarily associated with degeneration of the tubules, surgical attempts to overcome duct-occlusion are fully justified. We have now extended the use of testicular biopsy to the investigation of other types of infertility and by this means have been enabled to correlate semen findings with testicular changes. Without attempting to formulate any final classification, three groups of abnormalities in the seminiferous tubules may be distinguished: (1) A limitation in the intensity of epithelial activity which sometimes extends to the reduction of the epithelium to a single layer of indifferent cells. (2) Maintenance of epithelial activity with incomplete differentiation. For instance spermatocytes may be present in large numbers but may fail to change into spermatids. (3) The existence of a differentiation which is faulty. This condition is often combined with a degeneration of some of the intermediate or semi-differentiated cells which are present. In such testes one finds spermatocytes undergoing dissolution of the nuclear membrane, pycnotic spermatids, bi- or multi-nuclear forms and abnormal and normal spermatozoa. Sloughing of testicular cells is common and the sloughed material appears ultimately in the semen after having undergone further changes. The identification of this material in the semen enables us in many cases to draw conclusions concerning the state of the testes.

Testicular biopsy not only allows us to correlate semen analysis with changes in the testes, but may furnish indications for treatment. It is probable that it will also throw light on the causes of male infertility. All that can be said at the present moment is that the appearance of infertile testes does not often suggest the existence of some endocrine disturbance which can be remedied by hormonal stimulation. Rather does it suggest the intervention of some toxic factors, some of which we are now attempting to identify. It has, of course, long been known that the germinal epithelium is extremely sensitive to the toxins liberated by any infective processes in the body, and we have found that the elimination of these foci of infection will often restore fertility. Incidentally it should be noted that treatment by means of sulphanilamide is contra-indicated, since this drug may exert a harmful action on the germinal epithelium.

Mr. Green-Armytage has rightly laid great stress on the importance of the cervical barrier to conception, but whereas healthy and vigorous spermatozoa may penetrate even an imperfect cervical plug, weak and unhealthy spermatozoa may fail to penetrate a normal cervix. Therefore the condition of the semen may provide as clear an indication for artificial insemination as does the condition of the cervix. Another indication for insemination may be oligozoospermia. By centrifuging the semen all the spermatozoa may be concentrated in a few drops of fluid, which can be deposited within the cervical canal, thus preventing them from becoming victims of vaginal acidity, and of the vagaries of their random movements.

In order to give some indication of the frequency with which the male is responsible for barrenness in marriage, I will conclude by giving the following findings in seventy-seven cases which we have examined. In 23.4% of the husbands fertility was satisfactory, in 37.6% doubtful, in 18.2% markedly impaired, and in 20.8% there was complete sterility. It should be noted that male infertility may not only be responsible for failure to conceive, but also for conception followed by miscarriage.

[Dr. Wiesner showed slides of testicular biopsies illustrating Mr. Kenneth Walker's paper.]

**Mr. Aleck Bourne:** *Huhner's test in the investigation of sterility.*—Until recent years we have been mainly concerned with the part played by structure, as opposed to function, in the investigation and treatment of sterility. Little more than the condition of the cervix was recognized and the treatment consisted almost entirely of dilatation of the cervix in order to facilitate the entrance of the sperm through the small orifice of the pin-hole os. Incrimination of the retroverted uterus with its forward pointing cervix was a further example of the emphasis laid upon deformities of structure. The under-developed uterus was also considered to be a deterrent factor in conception, not because it indicated a low reproductive activity, but because it was believed to be an unsuitable nidus for the fertilized ovum.

The chief landmarks in the study of the function of conception have been the discovery of the influence of the gonadotropic hormones of the pituitary on ovulation and corpus luteal growth, the endometrial cycle in relation to the corpus luteum, the time of ovulation, the properties of the cervical secretion, the importance of the pH of the vagina, and recently the factors which govern the successful ascent of the sperm through the cervical canal.

At the present time the essential problems in conception are the function of ovulation and the meeting of the sperm and ovum in good condition. Apart from bilateral tubal occlusion the mechanical factors of sterility are probably of little importance, but whether or not the ovary produces an ovum either every month or at comparatively short intervals is the crucial factor. We assume from the existence of the secretory phase of the endometrium that a follicle has ruptured, but we do not know certainly that each follicle which ruptures always discharges an ovum, nor whether the formation of the ovum within the follicle is under the control of what we might call an oötroptic hormone independent of the follicle-stimulating hormone. Recently Mr. J. Suchet of St. Mary's Hospital and I have applied Huhner's test in an attempt to find for ourselves what happens to the sperm after coitus and have carried it out on 32 occasions since 1930. There are considerable difficulties in making the test, and it is impossible to make it as a routine part of every investigation, but on the whole the patients are co-operative.

Our small experience has taught us that the conditions which determine the viability of the sperm in the genital tract are not understood. The known factors to be taken into consideration are the condition of the husband's sperms as delivered, the occurrence of an orgasm in the female, the pH of the vaginal pool, the presence of vaginal pus, the amount of cervical mucus, and chief of all some unknown factor which Huhner calls cervical hostility.

The presence of a large number of active well-formed sperms in the vaginal pool exonerates the male in probably all cases. Examination of the vaginal pool sometimes finds them all dead. This may be due to necrospemia, and in all such cases the husband should be examined from a specimen taken from a carefully washed sheath. Many specimens handed to the pathologist in a sheath contain only dead sperms—killed by some substance applied to the rubber. Repeated examination of a specimen taken from a washed sheath often finds the sperms normally active. The pH of the vaginal mixture of seminal fluid, vaginal contents before coitus and the cervical mucus discharged during coital excitement is said by Séguy and Vimeux to be about 6.0. We have found the pH to vary between 4.6 and 8.0. We might expect the pH to be high if an orgasm has occurred, but one of my cases who had the orgasm showed pH of 4.5 with all the vaginal sperms dead, and another with pH of 7.5-8.0 contained sperms dead or dying. On the other hand another woman with vaginal pH of 4.6 had many active sperms. The effect of alkalinizing the vagina seems to be illustrated by a case in whom the first examination of the vaginal fluid found nearly all the sperms dead in a pH of 5.0. After using a pre-coital douche of sod. bicarb. the smear showed very many active sperms.

Much emphasis has been laid upon the pH of the vaginal pool as the chief factor which determines viability. Our own experience includes some cases where the pH does not seem to have so great an influence for at least two hours after coitus.

The presence of pus in the vagina is associated with dead vaginal sperms in some cases. There were five women who had a purulent vagina and in three the motility of the sperms was either defective or absent. It may be that trypsin in some specimens of pus may exert a lethal effect.

Examination of the cervical canal is the critical part of the test. We have found three main conditions—large numbers of active sperms, sperms present but all dead, or thirdly none to be found. A further curious feature is that the presence or condition of the sperm in the cervix has no relation to its condition in the vagina. For example I have found many active sperms in the cervix and all dead in the vagina ninety minutes after coitus and the converse state where they were all dead in the cervix and normal active

contacts of this kind. The relative preponderance of the second type in the sterile group corresponds to the shyness and diffidence so frequently encountered in this group.

TABLE III.—REACTION TO THE ONSET OF MENSTRUATION.

Control Group ...	Neutral, 3.	Resentful, 1.
Sterile Group ...	Neutral, 1.	Resentful, 1.
Dysmenorrhœa Group...	Neutral, 1.	Resentful, 2.

Fourthly, it is an axiom of psychological work that the nature and maturity of adult sexual interests supply evidence about individual development which is less open to error than many other criteria. The findings so far reported point to the occurrence among the sterile group of patients of delayed and inhibited maturation in all aspects of adult life. This is thrown into strong relief by an analysis and comparison of the adult sexual adjustment of the patients as shown by their behaviour.

These reactions have been classified under five headings: (1) normal orgasm, (2) occasional orgasm, (3) clitoris orgasm, (4) complete absence of orgasm (with and without repugnance), and (5) lastly, fear of intercourse, dyspareunia and vaginismus. In Table IV the last three groups are included under the heading "Ill-adjusted".

Table IV: It will be seen from the table that patients who are sexually mature, as shown by apparently normal orgasm, are distributed between the control and the sterile group in the proportion of 22:4. Conversely, gross abnormalities of sexual development, as shown by absence of orgasm, with or without repugnance to intercourse, are in the proportion of 3:15. Patients showing repugnance to or fear of intercourse, dyspareunia, or vaginismus in these two groups are in the proportion of 3:20.

TABLE IV.—SEXUAL ADJUSTMENT IN COITUS.

	Control (30 cases)	Sterility (30 cases)
Well-adjusted (normal orgasm) ...	22	4
Fairly well-adjusted (occasional orgasm or clitoris orgasm) ...	5	11
Ill-adjusted (no sexual feeling; no orgasm, dyspareunia; vaginismus) ...	3	15

*Personality types in sterility.*—As regards their personality the vast majority of the sterile patients were diffident in manner, juvenile or younger than their years in appearance, and without marked secondary sexual characteristics. They were often more ambitiously dressed than others of their class, or so differently, especially in relation to the use of make-up, that their total appearance could best be described as "doll-like".

Individuals of this type had frequently been the youngest or only children, obviously over-attached to the family rather than to either parent. Intensely shy, especially with grown-ups, they disliked school because of the roughness of other children and preferred to stay at home, even in adolescence, when their shyness prevented many outside contacts. Many of them as adults are interested to an unusual degree in their personal appearance, and obviously desire to attract; but neither before nor after marriage have they ever experienced any genuine adult sexual feeling. In fact, they are almost completely frigid and, corresponding to this, incapable of any deep affection.

A small subgroup of patients complaining of sterility are obese women, with strongly marked maternal attitudes, although they have never reached adult maturity in their instinctual development. Lastly, in a few parous patients subsequent sterility had been preceded, as they themselves pointed out, by a diminution or disappearance of sexual feeling.

*Psychodynamics.*—As to the mechanism by which the personality of the patients is related to their sterility, this is unlikely to be the direct result of infrequent intercourse. Many gynaecological authors, both ancient and modern, have suggested that the mental attitude of the woman, inhibition of orgasm by unrecognized anxiety, or lack of orgasm through emotional immaturity may interfere with conception by preventing the progress of spermatozoa. This might result from dryness of the vagina, from failure or reversal of possible vaginal peristaltic movements, or through spasm of the muscles of the pelvic floor and the cervix, with failure to retain the seminal fluid. It has further been suggested by gynaecologists that emotional development and frame of mind may affect the endocrine processes controlling ovulation and implantation.

To the solution of these problems hormonal research may furnish new clues.

Summing up, it has been shown that a personality type whose characteristics were described, prevails among sterile women. The ætiology of sterility, however, is probably complex. Our findings suggest that in an holistic approach to the disorder, a certain significance must be attached to mental factors.

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Examination of the cervical canal is the critical part of the test. We have found three main conditions—large numbers of active sperms, sperms present but all dead, or thirdly none to be found. A further curious feature is that the presence or condition of the sperm in the cervix has no relation to its condition in the vagina. For example I have found many active sperms in the cervix and all dead in the vagina ninety minutes after coitus and the converse state where they were all dead in the cervix and normal active

content in the vagina. We have found live sperms in the cervix within half an hour of coitus and Huhner reports finding them five days after coitus. In many cases there are no sperms to be found in the cervix despite a large number of active sperms in the vagina.

The most interesting condition is that in which there are many sperms in the cervix, but all dead. Here there has been no impediment to entry and yet after a very brief life in the cervix they have all been killed. Occasionally they are seen to be only feebly active and in a moribund condition. There is here, apparently, the influence of what has been called cervical hostility, and on an understanding of this depends further success in the treatment of sterility. The essential factor is the mucus from the cervical glands. It is spermotactic, variable during the month in amount, viscosity, and alkalinity, and its secretion is an important part of the coital mechanism.

It may be that the spermotactic power varies, but chief among all speculations is the existence of a spermicidal substance by which the meeting of sperm and ovum is frustrated. Huhner's test has a place in the investigation of sterility, but so far we cannot make very much use of its findings because we know so little of the factors involved. It may be that insemination on the right data might be indicated where the sperms in the canal are all dead. The cervical mucus may possibly be altered in its influence on sperms by the œstrogens or progesterone. But very much more research is necessary on this aspect of the function of conception.

**Dr. E. Schleyer:** The prevention of sterility is as important as its cure. I have found four conditions which contribute to sterility and where prevention is possible: (1) hypoplasia of the uterus, (2) gonorrhœa, (3) constipation, (4) abortion.

**Hypoplasia:** I should like to stress the association between hypoplasia of the uterus and nutrition. I have seen cases of hypoplasia occurring in women who had their early childhood or puberty in Vienna during the last war, when food was scarce. The so-called war amenorrhœa and sterility in Germany and Poland during and after the last war are well known. Abnormal menstruation at puberty and adolescence should receive more attention than it does as it may be the first signal indicating that development is not progressing normally.

**Gonorrhœa:** I have tested the tubes of 10 cases of gonorrhœa cured by sulphonamides. In 6 cases the tubes were found to be blocked within three to six months of the so-called cure of the disease. In 4 of these cases the blocked tubes were reopened by repeated insufflation. I suggest therefore that tubal insufflation should be considered part of the after-treatment of gonorrhœa in women as a preventive measure against sterility.

**Constipation:** There is a direct relationship between inflammation of the rectum and sigmoid and the pelvic organs, leading to pelvic cellulitis in the one case and salpingitis in the other and in consequence to sterility. Constipation causes proctitis and sigmoiditis and should be prevented in early childhood.

**Abortion:** I have found blocked tubes six or eight weeks after an abortion and these have mostly been reopened by repeated tubal insufflation. I suggest therefore that tubal insufflation should be considered part of the after-treatment of abortion; it is of value not only as a diagnostic but also as a therapeutic and prophylactic measure against sterility.

**Dr. Helena Wright** said she had had at her disposal the records of nearly 20,000 patients and they did not bear out Mr. Green-Armytage's contention that the use of Dutch caps and volpar paste caused cervical erosions or sterility.

## Section of the History of Medicine

President—Sir WALTER LANGDON-BROWN, M.D.

[November 4, 1942]

### Medical Polemics from Hunter to Owen, 1772—1844

By LILIAN LINDSAY, M.D.S.Durh., L.D.S.Edin.

At a time when revolution convulsed the political world the world of science was in the throes of creation; minds from which light was to spring were in a state of tension; some malign influence like that of Alecto made famous men, whose education and upbringing should have inclined them to philosophy and set them above those jealousies which afflict ordinary mortals, engage in long and bitter controversies.

As if aware of this influence and impelled to give an account of it William Hunter wrote: "There is scarce a considerable figure in anatomy that is not connected with some warm controversy, indeed if a man have not such a degree of enthusiasm and love of the art as will make him impatient of unreasonable opposition and encroachments upon his discoveries and his reputation, he will hardly become considerable in anatomy or any other branch of natural knowledge. These reflections afford some comfort to me who, unfortunately, have been engaged in two public disputes."

These reflections throw some light upon his strange quarrel with his brother John. Many biographers have attempted to explain the cause of their differences but have failed. William educated John in anatomy and would have sent him to Oxford had not John flatly refused to go as he said it would make an old woman of him. William introduced him to Cheselden, obtained a post for him in St. George's Hospital and a commission in the Army. As Denman said, William was a man of order and John a man of genius. William always acknowledged his brother's superiority and made a point of this in his lectures—"in this I am only my brother's Interpreter". John expressed his indebtedness to William in his letters from Belleisle in the Monro controversy over the function of the lymphatics. It is all the more strange that John should have made that violent attack upon his brother twenty-six years after the dissection which showed the nature of the placental circulation. John was more accessible than William; no one ever called William "the dear man" yet John's lectures were sparsely attended while William's were crowded with attentive listeners.

They were never reconciled. William was not present at John's wedding, John, although ministering to William in his last illness as one doctor to another, did not attend his brother's funeral; there is no mention of John in William's will.

These two brothers had revived the waning school of anatomy in London and when they departed the palm for teaching passed to Edinburgh where the first two Monros were making that school famous. Edinburgh was a hotbed of controversy; nepotism was rife, eight out of the ten professorships were held by the sons of former occupants of the chairs. The chair of anatomy was held by three generations of the Monro family; Monro *secundus* holding it for sixty-three years, the last ten of which, 1798-1808, were in conjunction with his son *tertius*, a scandalous arrangement, for *tertius*, secure of tenure, read his grandfather's lectures, ignoring the shower of peas from the catapults of the students which greeted the sentence "when I was a student in Leyden in 1719". He retired in 1846, the family having occupied the chair of anatomy for one hundred and twenty-six years.

Such a monopoly was not likely to remain unchallenged. On August 7, 1772, there is an entry in the Minutes of the College of Surgeons of Edinburgh to the effect that "Mr. James Rae (who had been deacon in 1764) has for several years delivered a course of lectures in surgery, discourses on cases of importance as they occur in the wards of the Royal Infirmary". These lectures were supported by the surgeons and advertised by them. James Rae had long urged that the teaching of clinical surgery ought to be separated from that of anatomy and the surgeons "desirous to promote every useful undertaking for the advancement of the knowledge of surgery" approached the University October 23, 1776, with a view to the establishment of a chair of clinical surgery for



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taught anatomy on the lines laid down by John Hunter as part of comparative anatomy; that and his crowded classrooms attracted the attention of the town and a chair of comparative anatomy was promulgated in 1798. This project aroused the furious opposition of Monro on the part of anatomy and Jameson on the part of natural history. Again Edinburgh was involved in the fight, so much so that Kay made a cartoon of this and called it "The Craft in Danger". Barclay is seated on the skeleton of an elephant trying to force a way into the University; James Gregory, this time on Barclay's side, is urging him on with the famous stick with which he thrashed James Hamilton and had to pay £100 damages for assault, saying as he did so that he would give twice that sum to have another chance. T. C. Hope, the professor of chemistry, firmly anchored in a bed of strontium (which he discovered), is hauling on the leg of the elephant to prevent its further advance; Monro is defying Barclay with a human thigh bone, while Jameson, the professor of natural history, seated upon a walrus, is dooming the doctor with the tooth of a narwhal, and Johnston the town councillor is waving to Barclay encouragement.

An interesting point arose during this dispute when the Town reminded the University of her origin which was as the "Toon's College", and that the Town, in consequence, had a right to a say in the affairs of the University. However, after a great deal of fuss on both sides things died down and there was no chair of comparative anatomy until 1831.

Barclay's class was an enthusiastic band of young men much younger than similar classes to-day. Many of the pupils became famous in after life; among these were Robert Liston, James Syme, James Wardrop and Robert Nasmyth. Liston was 16 when he joined the class and rose to be demonstrator and assistant. Syme first entered the University and dabbled in chemistry.

Syme joined Barclay's class. He was one of those men whose affections are deep and lasting and he became devoted to Liston who was his distant cousin. Scarcely had he been in Barclay's class a year when Liston quarrelled with Barclay and left the class to start one of his own in Brown Square, taking Syme with him. Syme was made assistant at once. This was awkward for Syme was 18 years of age while many of the 70 students who joined the class were his seniors. Though his knowledge of anatomy was not very profound his powers of concentration, his deft fingers, his assiduity in study, and his gift for teaching for which he was famous in after life now stood him in good stead, and he soon had control of the class. Liston left the anatomical side to Syme and devoted himself to surgery. The difficulty of obtaining subjects for dissection and the questionable method of obtaining them were not in accordance with Syme's character but to Liston there was no objection in beating the resurrectionists at their own game. These "honest tradesmen" at first affected to despise the new class and confined their attention to the University and Barclay, but when they found their quarry removed before they had a chance to obtain it they came to terms with Liston. Nevertheless Syme was disquieted and left the class to gain further experience in Paris where conditions were more favourable. He entered the classes of Dupuytren and Lisfranc.

Liston was in the meantime arousing the jealousy of the senior members of the staff of the Royal Infirmary, who accused him of making adverse comment on their teaching and of interfering improperly in the surgical department. It was resolved "that Mr. Liston be prohibited and discharged from entrance into the wards and operation room of the Royal Infirmary at any time and on any pretence whatever".

Liston fell back on his class and private practice and was joined in the latter by Syme. They were regarded as David and Jonathan: when Liston operated Syme assisted and when Syme operated Liston did the same for him. They gave papers to scientific societies which were certainly provocative if the opening sentence of one of Syme's papers is an example: "The deplorable ignorance of some practising surgeons in the matter of bone diseases is astonishing." The successes achieved by Liston with some of his operations could not be ignored by the authorities and at length he was reinstated on the staff of the Royal Infirmary, "his imprudence and presumption forgotten".

And now a coolness arose between these two friends the reason for which has remained an enigma. Paterson, who wrote the memorials of the life of Syme, states that it was the fruit of mutual jealousy, each recognizing in the other a brilliant surgeon and that a struggle for pre-eminence must ensue. It entered into all that they did and all that they wrote. In 1827 when a vacancy occurred on the staff of the Royal Infirmary, so impressed were the managers with Liston's personality that they were afraid to entertain Syme's application for the post, alleging as their excuse that they did not wish to risk unseemly scenes before the students, and Lizars, who was Liston's protégé, was elected in the teeth of the popular feeling in favour of Syme.

Syme had just created a sensation by a spectacular operation, excision of the lower jaw, for the first time in this country, in twenty-four minutes, "the patient enduring it with uncommon fortitude". This unfortunate man had applied to all the surgeons including

James Rae. As the University turned a deaf ear to this appeal, petition was made to the Crown, May 1, 1777.

This attempt to separate the teaching of clinical surgery from that of anatomy failed through the formidable opposition of Monro *secundus* whose astute mind foresaw encroachments in his department, and, very cleverly, he managed to have his chair of anatomy converted into a comprehensive one of "medicine particularly that of anatomy and surgery". This was all the more astounding as he practised as a consulting physician and, as Alexander Hamilton said, Monro did not teach even the rudiments of surgery. So the teaching of clinical surgery was relegated to the extra-mural school until 1802 when success was obtained by a promise not to interfere with Monro, and James Russell was appointed Regius Professor at a remuneration of £50 a year.

James Rae had devoted part of his lectures to dental surgery and another entry in the Minutes states that he was the first to lecture on dentistry and "to rescue that department from ignorant and unskilful hands". He gave private lectures on the teeth. His two sons, William and John, practised as dentists. William was elected to the College in 1777, he went to London and started practice in the Adelphi. His trade card in the British Museum is dated 1779. He was the first to lecture on dentistry in London at the invitation of John Hunter who advertised the lectures to take place at his house in Castle Street in 1783. The manuscript notes of these lectures were presented to the Royal Society of Medicine by Sir John Tomes who states on the fly leaf that a comparison of the signature of Joseph Fox with the handwriting of the notes convinces him that it was Fox who was the student who took those lectures down. It is somewhat difficult to reconcile this with the date of Fox's birth in 1776 and the early death of Rae from a fall from his horse. In any case he could not have attended the lectures in 1783 for he would have been only seven years of age at that date.

John Rae practised as a dentist in Edinburgh; he was Fellow of the Royal College of Surgeons of Edinburgh and President in 1804-5. His practice was described by the Hon. Henry Erskine as "suaviter in modo Et fortiter in RE". He was the moving spirit in the volunteers at the time of the threatened Napoleonic invasion.

James Gregory, of powder fame, was the fifth of his family to hold a chair of medicine. His was an extreme case; his father John Gregory died suddenly when half-way through his course of lectures and James, still an undergraduate, was allowed to deliver the rest of the lectures. Dr. Comrie in his *History of Scottish Medicine* says that the chair of the Institute of Medicine was vacant for some time and as the name of James Gregory appears next on the list he surmises that the chair was kept warm for James until he should have graduated. He went to Leyden and to Oxford before he took up his duties in Edinburgh.

John Bell was a Fellow of the Royal College of Surgeons and in 1790 lectured on surgical anatomy. He had a lecture theatre built for him to the east of Surgeons' Hall. He is described by Comrie as "an expert anatomist, good classical scholar, skilful draughtsman and etcher, ready speaker and polished writer". It was customary for the Fellows of the Royal College of Surgeons to serve in rotation in the wards of the Royal Infirmary. James Gregory attacked this custom with great vigour under the nom de plume of "Dawplucker". The managers of the Infirmary took notice of this and made a regulation in 1800 appointing six surgeons to serve in rotation for two years, excluding in this way the younger surgeons including John Bell. As a result a bitter conflict arose between John Bell and James Gregory, who snuffed up controversy "as the wild ass snuffs up the wind of the wilderness" and did not scruple to placard the town and even the door of Bell's lecture theatre with vituperative posters concerning Bell who replied with equal invective. Edinburgh became a battle ground of factions for and against. After a great deal of hubbub the affair died down; things returned to the regulation as it stood.

Bell developed a bitter contentious spirit which did some good for he was the enthusiastic champion of every new idea of any value, especially clean wounds and the anastomosis of arteries. Like William Hunter he educated his younger brother. Charles Bell was eleven years John's junior; he was persuaded to leave Edinburgh for London for John realized that no relative of his could hope for success in a town where such broils were raging against him. His health declined; he retired to Italy where he wrote some scholarly articles on Italian art. He died in Rome in 1820 and his grave is next to that of John Keats. In 1891 a deputation from the Royal College of Surgeons of Edinburgh went to Rome to place a Celtic cross on his grave; a tardy tribute to his great gifts.

One of John Bell's pupils was John Barclay whom John Brown describes as "a stickit minister and capital teacher of anatomy and common sense". The latter quality shines out in the dedication of his graduation thesis which was to "Dr. James Gregory and Mr. John Bell". Barclay was a brilliant lecturer and a serious rival to Monro *tertius*. He

was 15 when he joined the class; he served for three sessions as assistant in physiology and anatomy. It was said that Barclay had a "set of assistants most attractive to zealous and aspiring students". Nasmyth took the membership of the Royal College of Surgeons of Edinburgh, and then went to London as assistant to John Fuller, a dentist in Hatton Garden. The reason for this is obscure; there may have been some connexion between Andrew Wardrop, the uncle of James Wardrop, a fellow student, and John Fuller, but that is mere conjecture. Richard Downing, who edited the third edition of Fuller's *Popular Essay on the Teeth*, says in the preface that Rae, Moor and Fuller were the first to lecture on the teeth in London, and it is in this preface that the tragic end of William Rae is recorded. Downing also states that Joseph Fox was his brother-in-law. As this edition is 1815 and Downing alludes to Fuller as "the late" it must have been before that date that Robert Nasmyth went to London. It may have been the influence of Fuller and his own manual dexterity which determined Robert Nasmyth to adopt dentistry as a career, which he did on his return to Edinburgh; he took the fellowship of the College in 1823 when he published his one contribution to literature on *Tic douloureux*. His manual dexterity is mentioned by Liston in his *Practical Surgery*; in particular an appliance in gold for the restoration of the upper jaw after excision for a tumour. It is in Liston's work that mention is made of the first cap splint "devised by my friend Mr. Nasmyth of Edinburgh . . . to have metal caps fitted to the teeth of the upper and lower jaws soldered or riveted together at their bases which shall have the effect when applied of preventing the remaining fragment of bone and chin being dragged to the opposite side". This splint Norman Kingsley tells us in his *Oral Deformities* was copied in vulcanite by Gunning in 1856 and has ever since been known by his name. It is one of the splints in frequent use to-day in the maxillo-facial clinics.

Robert Nasmyth was appointed dentist in Scotland to George IV, William IV and Victoria, the chair reputed to have been reserved for the last august monarch is now in the museum of the Odonto-Chirurgical Society of Scotland of which body he was the first president. There is a contemporary biographical sketch of him in the *Forceps* 1844 "from the amiability of his disposition and gentlemanly deportment free from envy of his brother practitioners who, however talented themselves, concede to him and place him at the summit of the profession in Edinburgh".

He was the son of an Edinburgh clothier and his elder brother Alexander born in 1789, two years his senior, had been adopted by a childless uncle, a prosperous paper maker, printer and wholesale stationer. At a time of trade depression the business came to grief and Alexander was faced with having to start life afresh. He had been a keen student at the University in chemistry and natural history and had attracted the attention of Thomas Thomson, afterwards professor of chemistry in the University of Glasgow, to whom he now turned for advice which was that he should become a pupil of his brother Robert. It was no easy matter for a man of 33 years of age to study under a younger brother and it speaks volumes for the characters of the two brothers that this pupilage and tutelage should have been the undoubted success it proved to be.

At that time it was the custom for dentists to devote the early hours of the morning to treatment of the teeth of gratis patients and the number of these in Robert's practice was estimated at 1,500 to 1,700 in the year. These patients were used as clinical material for the teaching of the pupils and apprentices, and in this way Alexander gained experience. Later he went to Paris for further study under Audibran, a leading dentist in that city who specialized in porcelain work.

After a term with Audibran, Alexander Nasmyth returned to Edinburgh and then to London where he took the membership of the Royal College of Surgeons, London, and set up in practice in the neighbourhood of Hanover Square. It is likely that a nucleus of a lucrative practice awaited him among his brother's aristocratic and wealthy patients who had houses in the metropolis.

Shortly after Queen Victoria's marriage he was appointed dentist to the Prince Consort who, charmed with his personality and skill, recommended him as a dentist to the Queen.

All this time his chief interest was concentrated on his researches in the infant science of dental histology to which he devoted long hours of intense labour. It has been said that John Goodsir and Alexander Nasmyth were fellow pupils in Robert's practice but that is out of the question for Goodsir was born in 1814. It is true that Goodsir's father, a doctor in Anstruther, apprenticed him to Robert Nasmyth in 1830 and that so pleased was Nasmyth with Goodsir's progress that he was left in charge of the practice in 1835. Goodsir was a student under Robert Knox and succeeded Monro *tertius* as professor of Anatomy in 1846. He and Alexander had interests in common for both were working on histology and Goodsir in 1838 gave that classic paper to the British Association which was the accepted teaching for the next fifty years "On

Liston and all had refused to operate, diagnosing the tumour as malignant. He appealed to Syme saying that life was not worth living in his condition. Syme, whose skill in diagnosis was described by his great son-in-law Lord Lister as "resembling intuition but was in reality the result of acute and accurate observation and laborious experience well stored and methodized", diagnosed the tumour as benign and was justified in the result. Some years later when on a visit to America Syme received a visit from the patient who reminded him of how he had saved his life and Syme states in his *System of Surgery* that there was no greater deformity than a receding chin.

This operation did not improve the relations with Liston and so the lists were set. On the one side was Liston the handsome man, the giant in strength who could control the hæmorrhage with his left hand while he finished the amputation with knife and saw with the right hand, with only an assistant to support the limb: Liston who could amputate the leg at the hip-joint in less than a minute; the brilliant surgeon of the old school before the days of anæsthetics; and Syme the little homely man, equally brilliant, gentle and conservative, the first of the new school, shy and hesitating in his speech, but combative and, where the truth was concerned, tenacious in the extreme, with a knowledge of his own worth and a determination not to bury the talent with which he was endowed.

As John Hunter said, a surgeon without a hospital is like a gardener without a garden, and Syme, undaunted, looked about for a suitable place in which to start a hospital of his own. Fortune favours the brave; Minto House, the town house of the Elliotts of Minto, came upon the market, Syme acquired it and adapted it to his purpose.

Such was his reputation that when he advertised for two house surgeons he received eight applications. At that time a young surgeon paid for the privilege and experience of serving under a senior and Syme received £100 from each of his house men.

Things went from bad to worse with Liston for now some patients left the Infirmary for Minto House and one patient in particular, one upon whom Liston was about to operate, came to Minto House and Syme did the operation. Liston managed to get possession of the public subscription book for Minto House and wrote across the page "Don't support quackery and humbug". Of course this could not be tolerated and Liston had to make a full withdrawal and public apology and to pay the expenses of the threatened libel action. A climax was reached in 1833 when the aged professor of clinical surgery, James Russell, did an unprecedented thing—he offered to resign on condition that his successor paid him an annuity of £300. Liston as the leading surgeon in Edinburgh was offered the post but he refused the condition, feeling sure that no one else would accept it. What was his chagrin when Syme accepted the post with the condition. And now Syme had his heart's desire, entry into the wards of the Royal Infirmary, for certain wards were allotted to the professor of clinical surgery. As Liston was the senior surgeon in the Infirmary Syme, out of courtesy attended his lectures and operations undeterred by the unequivocal marks of contempt offered him by Liston. This did not last long for in 1835 Liston was appointed professor of surgery in the London University and left Edinburgh. And now came the dramatic reconciliation. Liston wrote from London: "I have no angry feeling towards you and you ought not to have any hostile feelings towards me; write and tell me that you wish our sores and grievances, not plastered over but firmly cicatrised; there's a surgical figure for you." And then as a postscript, as if with a twinge of conscience, he adds: "I am not so bad as you believe me to be."

It is just as probable that Liston was the aggressor in this quarrel as it is certain that he was the first to hold out the hand of renewed friendship without any suggestion of forgiveness on either side. Just as characteristic was the acceptance on the part of Syme of the proffered hand, he had always had a lingering affection for Liston. The storm had spent its fury, the skies were now clear never to cloud again; they remained fast friends for the rest of their lives. It is a psychological question whether they would have been reconciled had not a distance of about 400 miles separated their spheres of activity, for there is an old Scottish saying that friends are better apart.

The long quarrel with Liston, the dispute with Argyll Robertson, the contest with the law officers of the Crown for the principle of direct against hearsay medical evidence, the "battle of the sites" for the removal of the Royal Infirmary to the meadows of Lauriston and Syme's many private sorrows left their marks on his face. He seems to be the impersonation of Mr. Valiant for Truth: "'For though with great difficulty am I got hither yet now I do not repent me of all the trouble I have been at to arrive me where I am. My sword I give to him who shall succeed me in my pilgrimage, my courage and skill to him who can get it; my marks and scars I carry with me to be witnesses for me that I have fought His battles Who now will be my Rewarder.' And so he passed over and all the trumpets sounded for him on the other side." Lord Lister said of him that he was a good as well as a great man.

A fellow student with Liston and Syme in Barclay's class was Robert Nasmyth. He

## Section of Psychiatry

President—J. BRANDER, M.D.

[November 10, 1942]

### Psychiatric Effects of Severe Personal Experiences During Bombing.

By RUSSELL FRASER, I. M. LESLIE, and D. PHELPS

IN this war hardship and terror have been meted out to civilians in a random manner, and groups of normal population can be found who have all suffered a similar major disaster; with these groups it is possible to study the relative importance of various factors which may contribute to the development of neurosis after such an experience. During a recent survey in a heavily bombed English city, which involved the interviewing of approximately 1,000 individuals, one such group was studied in this way.

#### *Method*

(a) *Choice of Sample.*—Records were obtained of all the cases admitted to the First Aid Posts during the period of heavy bombing who were not recorded as physical illness or injury between the ages of 18 and 65. These were then visited ten months later, some months after the cessation of frequent bombing. It was anticipated that, while throwing some light on the reasons other than physical illness or injury which send people to a F.A.P., this would provide a sample of those who had suffered severe personal experiences, and a nearly random sample of those whose experiences had been severe. For it was the usual practice for the A.R.P. workers to send all these cases to the post for an examination to exclude physical injury: also others who had suffered lesser experiences were often sent for a wash, accompanying others injured at the incident, &c.

All traceable individuals were interviewed (127, or 75% of the "possible" sample and 59% of the listed names). These were first grouped according to the reason for their admission to the F.A.P.:—55% (Groups A and B) merely because of involvement in an incident, 34% (Groups C and D) because of uncomplicated nervous symptoms, and the remainder (Group E) because of nervous symptoms complicated by physical illness or injury. Groups A, B and C were pooled to study the causes of neurosis development and included all those who had suffered involvement in a precipitating incident; only Group A gives an unbiased indication of neurosis incidence—it comprises all those buried for over an hour.

(b) *Collection of data.*—All were first visited by a psychiatric social worker, and those still suffering from neurosis, as well as several others, were then visited by the psychiatrist, whose attention was directed especially to assessing the incidence of neurosis, its causes and the factors tending either to its persistence or to its recovery.

#### *Incidence of Neurosis and Allied Effects*

(a) *Neurosis.*—As indicated in Table I, among those who were buried for over an hour (Group A), approximately equal proportions developed no subsequent neurosis, a temporary neurosis, or a "persistent" neurosis, (i.e. symptoms still present at the time of the interviews ten months later). Table I has been arranged to show separately neurosis whose incapacitating effect was proved either by medical certificates or statements of absence from work without other cause; 40% of this group developed such neurosis—8% losing an average of three weeks due to "probable neurosis", 25% an average of eight weeks due to definite temporary or slight persistent neurosis, and 11% an average of thirty-one weeks due to persistent neurosis of moderate severity. It may be noted that when the neurosis produced an incapacity for over two months, it was very chronic. Among the 73 cases of neurosis in Groups A-C, there were only two instances in which the incident did not precipitate it within a few days of the event.

Evidently such a severe experience as being buried for over an hour, together with the many other disasters which often accompany this, is more usually followed by "neurotic" symptoms than otherwise, and it is the prolongation of these to cause more than two months' absence from work which should be regarded as an abnormality. Clearly the

the Origin and Development of the Pulp and Sacs of the Human Teeth". In an extended version of this paper in the *Edinburgh Medical Journal* in 1839 Goodsir expresses his indebtedness to Nasmyth for his instruction in dental anatomy and surgery. Virchow dedicated the first edition of his *Cellular Pathologie* to Goodsir—"the earliest and most accurate observer of cell life both physiological and pathological".

Alexander Nasmyth became a member of the Medico-Chirurgical Society in 1832. In 1839 he gave a paper to that society which made his name famous, on the enamel cuticle which has ever since been known as Nasmyth's membrane. He published a considerable work on dental anatomy in the same year. He was studying the cells of the dental pulp and the formation of dentine which tissue at that time was regarded as the ossified pulp. In the September of that year his name was on the programme of the British Association for three papers but when he arrived at Birmingham he was told that he could only describe his diagrams but that his papers would be published in full in the *Transactions*. When these were published the papers were only printed in abstract. Sir Richard Owen the next month, October, gave a paper in Paris in which he claimed to be the discoverer of the dentine-forming cells on the surface of the pulp. When this paper was published in the lay press a storm arose. A new partisan appeared in these controversies in the shape of the medical press, the *Dublin Medical Journal*, the *London Gazette* and the *Lancet*, in the last of which the redoubtable Wakley wielded a trenchant pen in support of Nasmyth. It seems futile now, and as the then secretary of the British Association stated in a subsequent letter to Nasmyth "it could all have been settled by any honest and sensible school boy in five minutes".

It seems after reading through all the wearisome pages of abuse and refutation which flowed out of the press in a perfect deluge, that in justice to all parties it is likely that Owen and Nasmyth had arrived at the same conclusion with regard to the cells now known as odontoblasts; that Owen from the vantage ground of the Council of the British Association had the opportunity of reading Nasmyth's paper beforehand and in an attempt to conceal his real motive, which was to be the first in the field with this discovery, he trumped up a charge of plagiarism against Nasmyth. Owen's bad taste is conspicuous in all these disputes and but for that, and the mean tricks which he played on other men, as for example Retzius, John Tomes and Mantell, his conduct with regard to Nasmyth might have been overlooked. Huxley says in a letter that "it must be confessed that Owen does some very ill-natured things now and then". After expressing his opinion that Owen is supreme in comparative anatomy Huxley says "I feel that I must always stand on my guard with regard to Owen". In the introduction to the classic work *Odontography* Owen puts a long footnote showing his spite towards Nasmyth and charging him with plagiarism on Schwann, knowing that this would go down to posterity with the effect of authority.

In 1852, four years after the death of Nasmyth, Huxley gave a paper to the Microscopical Society in which he said "the merits of Nasmyth have received such scant justice that I cannot do better than let them speak for themselves. Others when they come to work over this ground cannot fail to acknowledge them as I have done". These words reached only the few while the many have been influenced by the footnote in *Odontography*.

A contemporary described Nasmyth as "of florid complexion, sandy hair, strong Scottish accent, slender and muscular, gentlemanly and winning, benevolent, humane and liberal, ready to admit the merits of other research workers". Such a character could not fail to suffer under the coarse abuse showered upon him by Owen. In 1844 when the Royal College of Surgeons of London received a new charter and became The Royal College of Surgeons of England, Nasmyth was one of the first to be elected a fellow, an honour he treasured highly as a recognition of his work. Shortly afterwards he had a paralytic stroke and died in 1848. At a banquet in America in 1856 Chapin Harris, the pioneer of dental education in America and the first editor of the *American Journal of Dental Science*, rose to propose a toast "to the memory of a noble pioneer who fell a martyr to dental science, Alexander Nasmyth". Another example of the prophet in his own country.

This short survey of some of the contests at the end of the eighteenth and the beginning of the nineteenth centuries is a tale full of sound and fury, but it signifies that the contestants had such a degree of enthusiasm and love of the art as made them impatient of unreasonable opposition and encroachments upon their discoveries and reputation. All the contestants were considerable in anatomy and other branches of natural knowledge, and all, save one, were Scotsmen.

he had been torpedoed several times. At the time of the incident he had been enjoying his responsible post and his home life.

(2) Moderate persistent neurosis. Case S26 was a married man of 51 with no family, who had been in his shelter room when his home had been hit, covering him with debris up to his chest for two and a half hours. During this time, he had feared his wife was killed, was scared of the falling bombs and of not being found. His business—a small shop—had been destroyed by the incident. He was admitted to hospital with paralysed legs, which recovered spontaneously five days later. During the first few weeks he was depressed and worried over his affairs and over the pain in his back (nothing abnormal diagnosed by X-ray) which has persisted, and could scarcely sleep at all. He has been under doctors ever since, including a period in hospital for treatment to his back and to his "nerves". He only began to pick up six months later when he was able, with his wife's help, to recommence his business. He had previously kept good health, and been a cheerful, energetic and sociable person, well known in the neighbourhood.

(3) Slight temporary neurosis. Case S33 was a married woman of 46 whose house had been hit, covering her with debris in the gas cupboard for an hour; on her release bombs were still falling and she saw the large crater, so near—though she had not been very nervous before, she now felt "she could run for miles". Her son had been seriously injured beside her. She felt fairly well the next morning, but was worried and could scarcely sleep for some weeks; "one worry after another" had come upon her after this—her son's injury, her husband became ill and her daughter died with T.B., arranging a new house, &c. However she has since remained well, except for a period of a few weeks in bed in the winter when she was "run-down". She had previously kept good health and been of an energetic, stable personality.

(b) *Other effects. Trekking and evacuation.*—Both trekking and evacuation correlated with neurosis development, being highest in the persistent neurosis group, and lowest amongst those with no neurosis. Permanently moving to a safer area was more frequent in the neurosis group, but not any more frequent in the persistent neurosis group. Of Groups A-C 27% (24) later trekked—18% (17) regularly for a period of over two weeks; the majority of the trekkers had had very severe experiences or had been to the Post with nervous symptoms. 32% (29) of the same group evacuated for a period after their experience, and 55% (52) neither evacuated nor moved permanently to a less bombed district.

#### *Causes of Neurosis Development or Persistence after Severe Personal Bombing Experiences*

Using the group of all those who had suffered such experiences (Groups A-C) this problem was studied in two ways—(1) by comparing the incidence of various factual data in three subdivisions of the group (those who had developed no neurosis, a temporary neurosis, and a persistent neurosis), and (2) with each individual: after the interview an opinion was formed where possible of the main factors responsible for the development of neurosis, and for its persistence or recovery. There were only 94 individuals in this group of whom 73 developed neurosis.

(1) *The composition of the group and their bombing experience.*—Analysis of the age, sex and marital status of the group indicated that it approximated to the adult population of the area. Nearly all had had previous bombing experience average for this heavily bombed area (i.e. at least three months' exposure to fairly frequent and severe bombing near a target area); for 64% of the group the precipitating incident had involved being buried, and nearly all had lost their homes. Most came from a heavily bombed area of the city, and for over half the precipitating incident had occurred during a "blitz". The social status of the majority was that of the lower working class.

(2) *Analysis of the factual data.*—The important points of this analysis are summarized in Table II: space has precluded the inclusion of fuller tables.

TABLE II.—RELATION OF VARIOUS FACTORS TO NEUROSIS INCIDENCE AND PERSISTENCE AFTER SEVERE PERSONAL EXPERIENCES DURING BOMBING (GROUPS A, B AND C). 94 CASES.

Factor	No neurosis	Temporary neurosis	Persistent neurosis
Age, sex, m. status ...	Younger ? Males, fewer widows	—	—
Bombing experience ...	Less severe	—	Not clearly different
Abnormal personality ...	10% (Chronic neurosis)	34%	49%
Abnormal living conditions prior ...	0%	18%	18%
Abnormal emotional reaction at time	62%	59%	92%
Serious effects by raid on life ...	4%	43%	55%
No change of home area or evacuation	81%	51%	44%



extent of neurosis development depends partly on the environmental conditions, and on the treatment given—so the above figures can only refer to the city investigated.

TABLE I.—INCIDENCE AND DURATION OF NEUROSIS.

Group	Little or no neurosis			Temporary neurosis			Persistent neurosis			Total
	a	b	c	b	c	d	b	c	d	
A. Buried over one hour	6	4	2	5	3	—	3	5	4	35
	(34%)			(32%)			(34%)			
Total.—	(35%)			(34%)			(31%)			
Group A + B + C	21	7	5	20	7	5	11	8	10	94

NEUROSIS SUBDIVISIONS.—a—No neurotic symptoms. b—Neurosis without evidence of loss of worktime. c and d—Neurosis with evidence of absence from work. (1b and c—Probable neurosis. 11d and 111d—more severe symptoms than 11c and 111c).

Group A		Groups B & C	
Average worktime lost.	1c—3 weeks		2 weeks
	11c—5 weeks		2 weeks
	111c—8 weeks		5 weeks
	111d—31 weeks		21 weeks

*Criteria of neurosis and of abnormal anxiety during raids.*—In the interview inquiry was made for any physical symptoms of ill-health, and then whether he had been able to perform his usual tasks and habits. So a discussion evolved which usually elucidated the mood and preoccupations without its appearing to be directed to this end. Neurosis was judged to be present when there was evidence of any interferences with normal or usual mental activity, which had dated from this event and had lasted for at least a week. Only if there was this indirect evidence of mood or other neurotic disorder, and if it could not be attributed to any physical disorder, was neurosis noted. The severity of the neurosis was graded according to its interference with function. It will be remembered that actual worktime loss was usually used also to measure the severity—except for some housewives and retired individuals. When there was room for doubt concerning the neurotic basis of any incapacity, it was classed as “probable neurosis”.

The individuals were also asked about their tendency to somatic anxiety during raids. Symptoms subsiding within quarter-half an hour of the signs of danger (e.g. planes, or bombs) and not persisting with slight signs of danger (e.g. a “quiet” alert), were classed as average. Only when they were induced by slight stimuli or persisted over half an hour after the cessation of the stimulus were they classed as abnormal.

It is only to be expected that a large proportion (60%) were still more anxious during raids than they had been before the incident: 51% were then abnormally anxious during the raids. This may be compared with 45% for another random group of housewives living in a heavily bombed district of this city. In most instances where the experience had altered their tendency to anxiety during the raids, this change had been persistent.

*The type of neurotic symptoms.*—Little record was available of the clinical state on arrival at the Post. Evidently none were in very acute panic states; those admitted with nervous symptoms had been admitted in various degrees of emotional excitement, acute restless anxiety or depression, often with tremors, in “dazed” states or as “shock”.

The following types of neurosis were seen:—anxiety state (11%), anxiety and depressive state (56%), depressive state (16%), anxiety state hysteria (16%). In most of these instances of anxiety hysteria the disorder started as an anxiety state to which hysterical features were added later. Most of these cases were in the group with persistent neurosis.

The type of disorder discovered may be illustrated by a few typical case-histories:

(1) Moderate temporary neurosis. Case 3202 was a married man of 56 whose house was hit, burying him (for a quarter of an hour) and his family—two children were killed, the two others seriously injured, and his wife subsequently developed a neurosis. He spent about an hour helping to dig out the others; hearing their groans made him feel “in a mental frenzy”, and he finally fainted and was taken to the F.A.P., and thence to hospital. There he felt “terrible—miserable and collapsed”, did not sleep for two days, and vomited frequently during the first few days. He left hospital after a week, arranged all the family affairs, while living with friends out of the town—he found this a help as it prevented him thinking, but was completely exhausted each evening. During the first two months he felt very depressed and lost a stone in weight. Then he returned to his home and work, and began to sleep again, to feel less depressed and worried and gradually regained his energy. He is still somewhat below par but performing his responsible work efficiently. Previously he had always had good health and had been an energetic, stable, serious and conscientious person. In the last war

(5) *Conclusions concerning the causes of the neurosis persistence or recovery.*—From the previous factual analysis it emerges that neither living conditions prior to the experience, nor the nature of the bombing experience are important factors for persistence. But personality defects, severe emotional reaction at the time, and possibly disturbing effects of the incident on the individual's pattern of living are likely to predispose to this. Other important factors emerged from the individual assessments. While in the analysis continuance of living in the district did not appear to predispose, it must be remembered that several evacuees were not seen. Continuance despite lack of confidence did appear to be an important cause of persistence; delayed return to normal work, interests and activities were similarly found to be important. Clearly the individual may be helped by the Doctor or Social Agencies: apart from any other treatment, they may reduce these strains, promote an environment and attitude suitable for recovery, making appropriate adjustments as his condition improves. In these ways they had helped in some instances, in the majority they had intervened little or not at all, and in others they had even hindered by encouraging opposite attitudes and tendencies. Another relevant factor was the tendency for the neurosis to become very chronic if a disorder of moderate severity lasted over one or two months (see Table I); this suggests the importance of assisting recovery when this does not appear to be commencing within the early weeks.

#### SUMMARY

(1) A group of cases, who had been admitted to F.A.P.s in one English city during a period of heavy bombing, was followed up ten months later; all the traceable cases (127—76% of the possible sample) were visited; a severe personal experience had been the main reason for admission in 55%, and had preceded the admission in 75%.

(2) Of those who had been buried for over one hour (35), 66% developed neurotic symptoms, and 40% neurosis which had caused absence from work; in about equal proportions the neurosis was either temporary or persistent (i.e. for ten months).

(3) The type of neurosis among those who had suffered personal involvement was predominantly mixed depression and anxiety (56%) or either of these alone: a further 16% were cases of anxiety hysteria. 27% had trekked, and 32% evacuated for a period following the experience, while 55% neither evacuated nor moved permanently to a safer area of the city. During the raid ten months later 51% were abnormally anxious, and 59% had become more nervous during the raids.

(4) The causes of neurosis development or persistence were studied on the whole group who had suffered personal involvement (94).

(5) It appears that neurosis is likely to follow severe personal air-raid experiences, which at the time upset the individual emotionally, or produced a serious upset in the pattern of his living by destroying a much-esteemed home or a close friend, especially, but not only, if he is of unstable personality and was at the time living under some other strain.

(6) Neurosis, after such experiences, is likely to become persistent when the personality is unstable, living conditions have become an abnormal strain, either due to general difficulties or to residence in the danger area despite the absence of confidence. Recovery tends to occur when such factors are eliminated and the earliest possible resumption of full normal activities is facilitated and encouraged.

## Neurosis in a London General Practice During the Second and Third Years of War

By J. WHITBY, M.D., M.R.C.P., D.P.M.

THIS paper is intended to be a study of the effects of the second and third years of war on the neurotic or potentially neurotic elements in a London district. It is based on the records of a general practice with which I was associated for eleven years prior to the war and during the first half of the war. When I left this practice to take up psychiatric work entirely, the records were continued by my colleague, Dr. Patrick Walsh, to whom I am deeply indebted.

At the outbreak of war there were about 3,000 private patients on the books. Patients insured under the National Health Insurance Scheme have not been included in this study. They were mainly lower middle class, with a sprinkling of higher social grades, and were a fair sample of the district, except that the ratio of females to males was 2:1 as wives of panel patients would be included but not the husbands.

(a) Age, sex and marital status: The group is probably too small for a comparison of these factors, but there were more elderly people, females and widows in the neurotic group; many were made widows by the event.

(b) Bombing experience: The severity of the experience could not be satisfactorily measured, but the high incidence of neurosis, compared with what was found in the general population was clear evidence of the importance of this factor—if such evidence were needed. The non-neurotic group had suffered slightly less severe previous and precipitating experiences than the neurotic groups, but it did not appear that the persistent group was distinguished by more severe experiences.

(c) Personality: Except for 2 (10%) with other neurosis already present at the time, the non-neurotic group gave no evidence of personality abnormality, while in the temporary neurosis group 7 (24%), and in the persistent neurosis 17 (49%) did. Probably too high a percentage with apparently normal personality did develop a neurosis, for either its development or its persistence to be attributed mainly to personality defect, even if allowance is made for the difficulty of this assessment.

(d) Living conditions prior to the incident: For each individual an assessment was made as to the extent (if any) to which these conditions had provided unusual strains or restrictions.

Among the non-neurotic group none had had serious abnormalities, i.e. financial or other handicaps, worries, restricted interests or activities; 16% had slight difficulties of this sort. In each of the two neurotic groups 18% had had serious difficulties and 11% and 14% respectively slight difficulties.

(e) Emotional reaction at the incident—the subjective nature of the experience: Among Group A 50% had reported being abnormally upset; nearly all of these developed neurosis (90%). This was only more frequent among the group developing persistent neurosis. It should be remembered that all of Group A had suffered a very severe experience, and this may explain why an unduly severe initial reaction distinguished only the persistent neurosis group. While the high incidence of initial terror and upset should be correlated with the high incidence of neurosis in the whole group, the figures do suggest the importance of other factors, particularly for the temporary neurosis group.

This assessment is unfortunately only based on their own reports but probably gives some index of the initial psychic trauma.

(f) Other effects of the bombing incident on the individual's life: Two possibly important effects were available for assessment, the loss of a close friend, or of a home which was especially important to the individual—because of associations, of its being their work place (e.g. shop), or of its being the main interest of a restricted life, &c. Either or both of these factors were present in 25% of all individuals in Groups A-C; in 4% of the group developing no neurosis, 43% of the temporary neurosis group, and 55% of the persistent neurosis group. This appears to be related to the neurosis development but little to its persistence. In all but one of those who developed neurosis after being buried one hour both these factors, as well as the initial terror, had been present.

(g) Continuing living in the danger area: It is particularly hard to differentiate cause and effect here; but the figures are against this alone being an important factor either for neurosis development or for its persistence (see also below).

(3) *Individual assessments.*—For 64 (88%) of those who developed a neurosis it was possible to assess a main cause—in 49% the initial terror, in 29% other effects of the incident on the individual's life, in 13% the instability of the personality, and in 7% other miscellaneous factors.

Causes of persistence were assessed in 64 cases. Apart from personality or constitution which seemed to be the main factor in 21%, two main social settings stand out as being judged mainly responsible for its persistence, in 31% living conditions since the incident which had caused abnormal mental strains (broken homes, financial strains, changed work, long travelling and working hours, worries about children, invalids in the family or home, living in partly damaged or inadequate houses, &c.) and in 41% continued residence in the danger area despite loss of confidence. Among 25 (44%) cases recovery was mainly attributable to environmental factors—58% to reduction of the exposure to raids (i.e. by temporary or permanent removal from the area, or the later decrease of raids) and in 18% to the resumption of normal work interests and activity when adequate recovery had occurred.

(4) *Conclusions concerning the causes of neurosis development.*—The above analysis indicates that neurosis is likely to develop, especially in an individual whose personality is defective, or whose living conditions at the time of the experience were either restricted or a strain, but also in others if the incident upset them emotionally and seriously disturbed the pattern of their life as by destroying a much-esteemed home or a close friend.

evacuation of the predisposed, a sort of natural selection, and although many of the evacuated came up to see me periodically, they attended less often than normally, and there must have been a still greater relative rise than the graph indicates.

There was no change in the sex ratio which, as in 1937, was two females to one male for all illness; and 3 females to one male for nervous illness. The average age of this

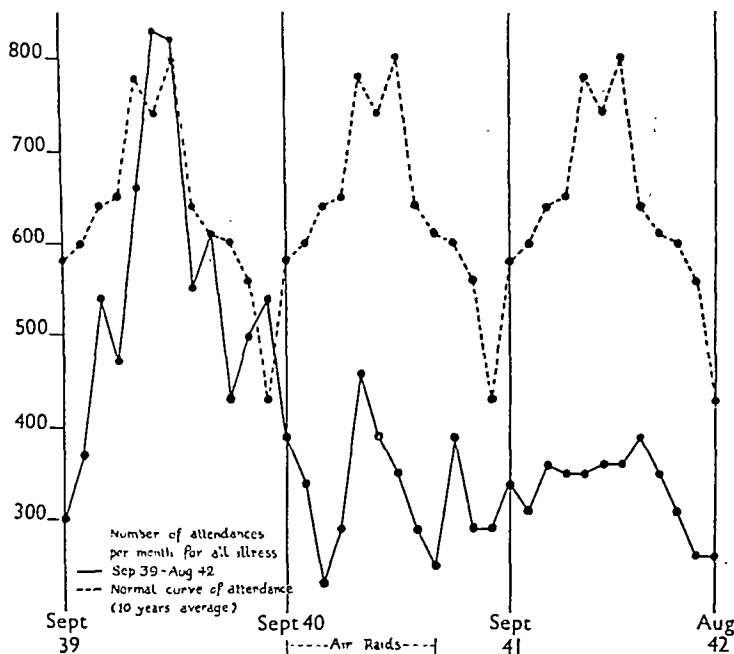


FIG. 1.

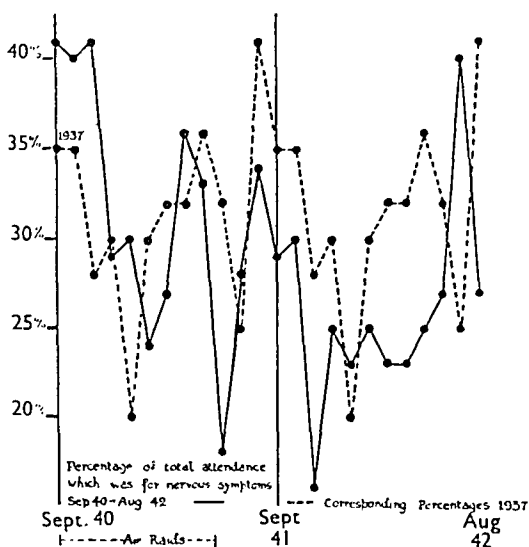


FIG. 2.

To study the incidence of neurosis in war, we must first define what is meant by the term "neurosis" for this purpose. In the mild cases seen in general practice the question of physical predisposition is much more important than in the chronic or severer cases seen by the psychiatrist. It is a commonplace to see in the same patient a mild anxiety state or depression associated at one time with an infection, at another time with psychological stress. Symptoms or signs referable to disturbed functioning of the nervous system may occur with, and be symptomatic of, structural physical disorder, and yet be aggravated by either the progress of the disease or by psychological factors. The relation of physical factors to the mental ill-health may be of all degrees, from mere concomitance to main cause, and the predisposition may frequently be both physical and psychological, the proportions varying from case to case, and in the same case at different times. To disentangle such factors which might be either cause or effect in the same case would make the task unnecessarily complex, and it was, therefore, decided to study nervous symptoms rather than strict neurosis. Under this heading would be included such symptoms as nervousness, depression, insomnia without obvious physical cause, and such signs as those of somatic anxiety or conversion hysteria. In practice about half the cases seen had physical disorders also, due partly to the foregoing considerations and partly to the fact that many of these patients were not accustomed to seek treatment for minor nervous disturbances, and only came when some physical disorder gave them an excuse.

The number of such patients seen in the two years was 330, but as 20 had incomplete records they are excluded from analysis, although they appear in the attendance figures.

A further 35 were not known prior to the period studied and are rejected, leaving 275. Of these, 234 had nervous symptoms during this period and the remaining 41 were seen for physical illness, but had a known predisposition to nervous symptoms. Known predisposition is rigidly defined as having had treatment for such symptoms before September 1940, and generally, it was pre-war. Anxious personality, mild enough never to have required treatment, even bromides added to their medicine, was disregarded, as was inference from present symptoms.

The inquiry falls naturally into two periods, September 1940—May 1941, during which the air raids on this district occurred, and June 1941—August 1942, when the district was raid free. The incidence of neurosis in the first period has also been reviewed by Dr. Aubrey Lewis in the *Lancet* (1942 (ii) 175).

The amount of bombing was about average for a London suburb. Severe experience was small and only nine of these patients had been bombed out of their houses, although this had occurred to some other patients also, without the development of nervous symptoms. Broken windows and minor damage to houses was common. Two had had relatives killed in their presence; a number had seen injuries and a smaller number sustained injuries.

To study the incidence of nervous symptoms, a comparison has been made with 1937, which was the last peaceful year. In this year there were nearly 8,000 attendances among 1,237 patients, and 30% of the attendances were for nervous symptoms. The picture changes, however, when we look at the monthly distribution. Fig. 1 gives the percentage of total attendance which was for nervous symptoms, and, in 1937, shown by the dotted line, the percentage ranges from 20% in the winter, when physical illness is frequent, to 41% in the summer when such illness is low, chronic neurosis being little subject to seasonal fluctuation. The other line gives the corresponding percentages for the period studied, and it will be seen that September, October and November 1940 were abnormally high, whereas the remainder of the year was about normal, with minor variations, due to seasonal differences. The percentage for these three months was 41% as against 32% for the corresponding period in 1937. Percentages, rather than absolute figures, are used as being more reliable for an available population fluctuating in size.

To interpret this, one must consider whether the composition of the population had altered materially. That considerable movement of population had occurred is shown by fig. 2, which gives the total attendances, compared with the normal curve of illness, based on ten years' average. This demonstrates the effect of evacuation at the beginning of the war, but shows that, by September 1940, attendance had nearly returned to normal, and most evacuees, apart from children, had returned. A fresh evacuation caused another sharp drop in September 1940, with a continued fall for three months. Individual case-histories show that evacuation proceeded steadily during these three months, and then practically ceased. How did this affect the proportion of patients predisposed to nervous symptoms who remained? An investigation of the percentage evacuation amongst the different groups of these patients, showed that aggravated cases evacuated more than stationary, and predisposed more than non-predisposed. Hence there was a differential

always due to air raids and often benefited by a short discussion of their problems, as well as sedatives. As opportunity occurred for most of them to be seen again, for various reasons, during the next period, the results of treatment will be deferred until this period has been discussed. This covers June 1941 to August 1942, during which there were no raids in the district. The curve of percentage attendance for nervous symptoms (fig. 1), is of normal shape, with summer and winter fluctuations; though these were in different months to 1937, but it runs at a lower level. The total attendance for the third year of war was 4,000, as in the second year, but only 26% for nervous symptoms as against 31% in the previous year and 30% in 1937. To interpret this fall again requires consideration of the composition of the population. The total attendance curve for the year (fig. 2) is grossly abnormal in that it hardly shows the usual winter rise, which is a new phenomenon in my experience. The explanation appears to be that during the summer, after the raids, people no longer neglected their minor illnesses, but when the evenings grew dark they did. Furthermore, during the winter the available population declined owing to my continued absence from my practice, and to more absorption of women into war work, when they became insured patients or moved away, so flattening out the normal winter curve. In the summer of 1942, the decline was neutralized by renewed attention for minor illness and return of evacuees. Thus the total remained stationary. There is evidence that all these factors were operative, but the only one that affects the neurotic population especially, is the return of evacuees, which took place more among the healthy than the predisposed, and so lowered the percentage of predisposed in the district. This is not enough to account for such a fall in nervous symptoms. All this suggests that the mental health of the resident population remaining, was better than pre-war. Table I gives some direct

TABLE I.—COMPARISON OF MENTAL HEALTH SEPTEMBER 1940—MAY 1941  
AND JUNE 1941—AUGUST 1942.

		Well or No. improved	Same	Worse	Not seen again
Attended for nervous symptoms, September 1940—May 1941	168	66	44	18	40
Well September 1940—May 1941, but either of known predisposition or developed illness later	107	37 (well throughout)		66	4
	275	103		84	44

evidence on this point. This is a comparison of the mental health of ill or predisposed patients in the two periods, and shows that 84 were worse; at least 66 better; and 44 not seen in the second period. The majority of the latter, however, were not chronic, but intermittent attenders, who would have come in again if they had had symptoms, so the probability is that more were better than worse. Further evidence is supplied by the fact that out of a remaining population of at least 1,500, there were only 20 new cases of no known predisposition as against 47 in the first period.

It must not be assumed that this low level of nervous symptoms in the remaining population implied a low level in the original population of the area. There was still a relatively large proportion of potential neurotics remaining evacuated, and gradually going to other doctors. Nevertheless a rough estimate of the amount of drop in attendance due to this still does not cover the decline, and the conclusion must be that the amount of nervous symptoms for which treatment was sought, was slightly lower than pre-war. The 66 new cases seen in this period occurred in predisposed persons in 46; more than half were unrelated to war, and 17% were mainly due to physical illness. In addition, many of the previous group were seen, 18 for fresh exacerbations, others for stationary or recovering nervous illness, or for physical disorders. The new questions of girls going into industry arose only in the insured population and are not studied here.

These cases resembled those of the previous period in their symptomatic diagnosis and mildness, but the occurrence of a few prolonged, though not severe depressions, was a new feature. These were often associated with war problems.

The early and late results of treatment of the earlier group of cases may now be considered. Table II shows that the immediate outcome of illness was good in the predisposed, if not chronic, and very good in the non-predisposed. The late results showed some tendency to deterioration in chronics, but improvement was generally maintained in the others, especially as many of those not seen again were probably not needing treatment.

It would be premature to give figures about the 66 late cases, but my impressions have

population rose from 45 to 48, due to the fact that evacuation of young mothers, and absorption elsewhere of the younger elements more than counterbalanced the evacuation of the elderly; but this could not account for more than a little, if any, of the rise, as this should produce a corresponding rise in physical illness.

To test whether an apparent rise might be due to a fall in physical illness, the expected attendance for each kind of illness was calculated by deducting the effect of evacuation, the amount of the latter being known by a local official survey. It was then found that the attendances for physical illness, in the three months, were so far short of the expected figure, that it must mean that people were not bothering about minor illness. This was known to occur by the reports of patients, but that people were equally neglecting their nervous illness is shown by the fact that the ratio of attendances, per patient, was running at an equally low figure for both.

It must, therefore, be concluded that there was a small but real increase in nervous symptoms, sufficiently marked to require treatment for them, during September, October and November 1940. What was regarded as a normal degree of apprehension in relation to air raids has not been included.

During the next six months of air raids, nervous symptoms were 30% as against 29% for the corresponding period of 1937, and the curve is of approximately normal shape. Evacuation had now ceased. The total attendance curve shows the usual seasonal fluctuations, but the amount of attendance was about half normal. This was due to the absence of epidemics, the continued neglect of minor illness and later on, my own absence on other work. There is other evidence that the impact of the air raids had worn off. Case-histories showed that mild cases had largely cleared up. The ratio of attendances to patients for nervous illness had risen slightly, as mild cases ceased to attend, but was still below the normal figure, due partly to evacuation of chronics, as well as failing to attend for treatment. If one allows for the evacuation of the neurotically predisposed, there was probably a very small rise persisting in this period. The bulk of the population had adjusted to the new conditions, and found a feeling of security by all sorts of devices. Bedrooms on upper floors were now scarcely used, and people slept either downstairs or in Anderson or other shelters. To many, sleeping under a table, or under the stairs, gave relief. Very few of these people went to tubes or out into the country to sleep at night. Much ingenuity was used to make the new conditions tolerable and very few complained.

The aetiological factors in the 113 aggravated cases of these nine months were many, but could be broadly classified into: (1) Air raids. (2) War problems, by which is meant other psychological stress directly due to the war, such as occupational and evacuation difficulties. (3) Domestic problems, such as family anxieties or marital infidelity. (4) Personality problems where difficulty in pre-war adjustment existed and there was no apparently adequate precipitating circumstance. (5) Physical: where the symptoms were considered to be mainly due to physical disease.

These factors were, naturally, often multiple, but if a somewhat arbitrary selection of the main factor be made, more than half the cases were not directly related to the war, and, in one third of the total, war problems predominated. Air raids were relatively more important in those of known predisposition. Physical disease was the main factor in 8%, but contributed in others. Where air raids were a factor, the first attendance was in the first three months in 71%, whereas where war problems were factors, only half the cases attended so early. Thus air raids gradually decreased in importance, and war problems rose.

The number of attendances and duration of treatment for the exacerbation or illness, showed a close correlation between predisposition and severity, as judged by this standard. Thus: the 28 aggravated chronic cases, averaged nine attendances over sixteen weeks; the 58 aggravated predisposed, four attendances over six weeks; and the 27 non-predisposed, two attendances over three weeks. Clinical records confirmed this, and neurosis of any severity was almost unknown, without known predisposition. About half the predisposed had mild illnesses and about three-quarters of the non-predisposed. The mildness of the illness, in the latter, is shown by the very small number of attendances, but there were about another 20 cases in this group not included here, as their mildness did not justify detailed analysis at the time. Patients presenting only what was regarded as a normal degree of apprehension are not included at all.

The clinical classifications were mixed, as usual in psychiatric practice, and the cases were no different in kind to those seen pre-war. To go by the main symptomatology, 60% were mainly anxiety states, 35% mainly depression and 5% mainly hysteria. Depression was slightly commoner in the non-predisposed. The milder anxiety states were not

## Section of Otology

President—F. C. ORMEROD, F.R.C.S.

[November 6, 1942]

### DISCUSSION ON THE PREVENTION OF CHRONIC OTITIS AND DEAFNESS

Mr. W. Stirk Adams: Though the preventive approach to otitis media has been widely practised during the past twenty years there is still a high proportion of chronic suppurative otitis media in existence, and I am able to supply four recent references bearing on this incidence.

The most complete figures are those for recruit examinations in the American Army of 1918 (Britten, 1941), and cover nearly a million men. The average incidence of chronic suppurative otitis media per thousand drafted men in that year, throughout the country, was 6·81, and while this average was nearly true for many of the States, variations between 15·14 per thousand in Rhode Island, with New York and Pennsylvania following closely, at one end of the scale, and Florida with 1·29 per thousand at the other. Again from America is a preliminary statistical report of volunteers in the Southern New York district of the Second Corps area (Leone, 1940)—June, July and August 1940, ages 18-35—where in a total of 6,047 candidates, 32·5% were rejected, and of the rejects 10% were due to failure to meet the hearing requirements. The majority of this group were found to be suffering from purulent otitis media in acute or chronic form in one or both ears associated with impaired hearing. While, again from America, in the examination of the National Guards pass reports (Haas, 1941), 7·2% of chronic suppurative otitis media were found in 4,158 examinations in November 1941: while ear defects, including deafness here constituted 15% of total rejections.

In this country, in reporting the first thousand cases which attended the Ear, Nose and Throat Department in a Military Hospital in 1941, Major D. H. Craig (1941) states that of these 243 were of chronic suppurative otitis media, and reflecting on the value of recruiting statistics, he states that in many cases, though the patient had an obviously long-standing chronic ear, no note of this fact was found on his medical history sheet, and he adds: "It would seem that a routine examination of the drumheads on enlistment is not always made. It is likely that the incidence of chronic suppurating ears among the troops in the area is actually much higher than the actual figures relate—a melancholy reflection when one considers that efficient local treatment in the early stages of an acute otitis media would render the chronic ear non-existent."

Chronic suppurative otitis media or its sequelæ is found most often in those whom we regard as the hospital class, and while we know that an acute otitis can develop and pass into a chronic infection in an adult, particularly in epidemic times, most adults obtain treatment for this condition. It is in children, however, that the largest numbers of acute middle-ear infections are found. In the Children's Hospital, Birmingham, for many years we have averaged between 600 and 700 new patients every year under treatment, and in one year (1939) the total was over 1,000.

From January to October 1942, 1,036 patients have applied to us for treatment for acute otitis media and of these 227, 21·5%, were under the age of 1 year. The majority of these are treated as out-patients but in any case where the response to treatment is unsatisfactory the child has been admitted to the wards. My thanks are due to the Board of Management at the Children's Hospital and to my colleagues on the Medical Staff for their co-operation. In the past year my Board has allocated one-sixth of the



been that although mild, they tend to be more prolonged, and not to recover so completely. This would correlate with the fact that causal factors are persisting in many of them. The question of the extent to which those of known predisposition developed a nervous illness or exacerbation, may now be answered. Of 228 such patients seen, 38% were aggravated in the first period and 24% in the second period, but one-third remained well,

TABLE II.—EARLY AND LATE RESULTS OF TREATMENT IN PATIENTS SEEN FOR NERVOUS SYMPTOMS. SEPTEMBER 1940—MAY 1941.

Cases seen September 1940— May 1941	No. 28	Condition when last seen September—May			Condition when last seen June 1941—August 1942 compared with the earlier period				
		Not needing treat- ment	Partially recovered	Not improved	NNT 1	PR 8	Stat. 8	Worse 6	Not seen 5
Chronic aggravated	44	—	—	44	—	1	31	8	4
Chronic improved	11	—	11	—	—	6	1	1	3
Illness known pre- disposition	58	30	23	5	11	19	4	1	23
Illness no known predisposition	27	20	6	1	17	3	—	2	5
	108	50	48	70	29	37	44	18	40

or better, throughout. As 228 is considerably below the number of persons of known predisposition remaining in the area, who would have attended if they required treatment for any cause, the proportion of such persons who had no nervous symptoms for which treatment was sought, must have been much higher, probably at least one-half.

### CONCLUSIONS

The 8,000 attendances during the second and third years of war have been analysed for nervous symptoms. There was a small but definite increase in nervous symptoms during the first three months of air raids in September. October and November 1940, but the incidence then gradually fell to normal, and became below normal after the raids ceased. These cases were mild, at least half not directly due to war, and in the others, war factors other than raids, became increasingly important. Those known to be predisposed accounted for 75% of all cases. A follow-up of 228 persons known to be predisposed showed that at least one-third had had no exacerbation of their symptoms throughout

These conclusions indicate that the low incidence of severe neurosis seen by the psychiatrist is paralleled by a similar low incidence of mild cases seen in general practice and is a gratifying indication of the good morale existing in this London district.

Register or Diploma in Otological Nursing. I suggest that such a Diploma and Register should be established.

*Fourth:* The education of the Public in the necessity for early treatment. During the last twenty years the Otological Section of the School Medical Service in our larger cities has done fine work, and a similar service of the highest standard should become a general rule. The results according to the figures of Crooks quoted by Norvick (1940) show that the incidence of chronic otitis in 1934 in London school children had been reduced to 0.9%, while in the adjacent county of Essex in the same year it was 4.8%.

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Mr. E. Naylor-Strong : An audiometric clinic was established in Birmingham two or three years before the war in which a large part of the juvenile population of the city schools were tested. They were tested twice with a gramophone audiometer, but these tests and investigations have unfortunately been discontinued since the outbreak of war.

I am indebted to Dr. Mitchell, the Schools Medical Officer of the Education Department of our city, for permission to use the figures obtained in the Audiometer Clinic which was partly under my jurisdiction. Three districts of Birmingham have been singled out as representative. The first and last were rather poor districts, heavily populated, but the middle district was of a rather better class, but still of the class attending the elementary schools.

All the scholars in the schools were tested (Table I), and from the poor district,

TABLE I.—AUDIOMETRIC TESTS.

Number of Children Tested (Tests 1 and 2)

Clinic District	Boys				Girls				All Children	
	Passed	Failed	One ear	Two ears	Passed	Failed	One ear	Two ears	Passed	Failed
Sheep Street ...	1,718	96	56	40	1,792	125	86	39	3,510	221
Yardley Green Road ...	2,357	154	119	35	2,242	123	91	32	4,599	277
Aston ...	1,703	85	66	19	1,385	80	63	17	3,088	165
	5,778	335	241	94	5,419	328	240	88	11,197	663

Number of Ears Tested (Tests 1 and 2)

Clinic District	Boys' ears		Girls' ears		All ears	
	Passed	Failed	Passed	Failed	Passed	Failed
Sheep Street ...	3,402	136	3,670	164	7,162	300
Yardley Green Road ...	4,833	189	4,575	155	9,408	344
Aston ...	3,472	104	2,833	97	6,305	201
	11,707	429	11,078	416	22,875	845

Hearing Acuity for All Ears by Groups

Clinic District	A (-3 to +6)	B (+0)	C (+12 to +18)	D (+21 to +30)
Sheep Street...	7,162	51	158	91
Yardley Green Road ...	9,408	67	156	121
Aston ...	6,305	26	101	74
	22,875	144	415	286

so-called, out of 3,731 children tested, 221 failed, roughly 6%. The sexes were about equal. In the second district, which was rather better class, out of 4,876 cases, 277 failed to pass, 5½%. In the third district, out of 3,253 tested, 165 failed to pass, 5.1%. It will therefore be seen that the number of children whose hearing is not good, attending the city schools, is high. These are all children between the ages of 5 and 14, and no doubt if we took the whole population, the figure would be higher. There does not seem to be very much difference in incidence of the disease between the very lowest class of children, and those a little more fortunate. I regret that I have no figures for the secondary schools, which would have been interesting.

The second section of the Table shows actually the number of ears, and gives an index of whether one or both ears are affected. Out of 23,720 ears, 845 were not up to normal standard of acuity, roughly 3.7% of all ears.

available accommodation, reduced as it is owing to the Hospital being in a target area, to the treatment of these cases.

Out of a total of 292 patients admitted to the in-patient department from October 25, 1941, to August 8, 1942, 210 were suffering from acute otitis media and of these 134, 64%, resolved on treatment by paracentesis where required and M & B 693, while 74, 36%, required a cortical operation. Two patients, both infants, died from intercurrent enteritis. All the survivors were discharged from hospital with a dry ear, and nearly all with an intact drumhead. To give some indication of the type of case in which these results are obtained, Table A shows the duration of the aural discharge prior to admission in 20 patients who were under treatment in the ward on October 29, 1942.

TABLE A.—DURATION OF DISCHARGE BEFORE ADMISSION.

Days	1	1-5	5-7	7-10	10-14	14-21	21-25	25-30
No. of cases	2	4	5	1	3	1	2	2

But there is another aspect to this problem, and in the years 1937-1941, 47 children have had a radical or modified radical mastoid operation performed. The accompanying table shows the age of onset of the infection which terminated in a radical mastoid operation—in some cases many years later.

TABLE B.—AGE OF ONSET OF OTITIS IN 47 RADICAL AND MODIFIED RADICAL MASTOIDS. CHILDREN'S HOSPITAL, BIRMINGHAM, 1937-41.

Age	0-1	2	3	4	5	6	7	8	9	10	11	12 or over
No. of cases	11	8	7	2	7	2	1	4	1	1	2	1

While these results are obtained in cases which reach the hospital for treatment, from our experience it is evident that a large number of acute infections pass into chronic infections without otological treatment. Two recent experiences illustrate this point. Some six weeks ago in my out-patient department I examined 2 children:

A boy 9 years old has a chronic suppurative otitis media with a large attic defect. His history is of a discharge of three years' standing which has continued without intermission. No advice has been sought as there has been no pain. Pressure has been brought to bear by the School Medical Service who have advised removal of adenoids, which has been refused by his father. As the father suffers from ear trouble himself, he is now willing to allow an operation on the child's ear.

The second case is that of a boy aged 6, whose ear began to discharge three years previously after pneumonia, and has continued to do so. Hydrogen peroxide has been used by his doctor. The child was brought to hospital independently by his mother because of her anxiety about his ear. A wide inferior destruction of his drumhead was present, a chronic discharging ear, and hearing was reduced to six inches distance for the whisper.

There are four important measures in the prevention of this condition.

*First:* Adequate education of the medical practitioner in the handling of an acute otitis. I regard it as important to diagnose and treat correctly an acute ear as an acute appendix (and the acute ear is much the commoner). It is difficult to give a student an adequate knowledge of this subject unless he spends an internship in the acute otitic ward. It has been suggested that otolaryngology should be regarded as a post-graduate subject, but if this view is accepted the recent graduate will have an inadequate knowledge of diagnosis and treatment of this condition when he meets it in practice. The regulations for qualification should require an internship in an acute otitic ward prior to graduation, and the inclusion of a written and practical examination in otology in the final examination.

*Second:* The provision of sufficient in-patient accommodation in acoustic centres for the treatment of acute otitis wherever required. It is a common experience with us that at the height of an epidemic it is sometimes difficult to obtain in-patient accommodation for a classic mastoid in a child, and it is just at these times that any less urgent otitis is likely to pass into a chronic condition.

In this connexion I would stress the urgent need for providing further accommodation for infants. One-fifth of all acute otitis in children occurs under the age of 1 year, and in these infants the otitis is frequently a part of a general medical illness. A highly specialized barrier nursing is required, and the closest co-operation with the Department of Internal Medicine must be maintained in treatment.

*Third:* The provision of an adequate acoustic staff trained in the work. This applies not only to our profession, but to the profession of nursing also, where there is no

Turning now to the question of deafness after mastoid operations, excluding radical ones, in the 881 non-treated cases there appear 81 who have had mastoid operations. These were emergencies, and had not been treated in any way for their loss of function. They were done at various institutions, and are a cross-section of the results from many sources. The proportion is roughly 10% of the whole group. In the children treated, the number of post-operative mastoids that were deaf was only 19, and these had received special consideration for their deafness by one surgeon.

We can, therefore, say that while 81 cases out of 881 occur in the non-treated group, only 19 out of 1,019 appear deaf in the treated group. These were tested twice, and out of 81 untreated ears on the second test, only 4 managed to pass, i.e. 4 spontaneously improved. In the treated cases three months later, the 19 were tested again, and out of those 7 passed, just over one-third.

If then, after a mastoid operation, in which the hearing of the child, and all the factors associated with this, are taken into account at the time, we can expect that in 1,019, 12 cases will be deaf to a marked degree. All the others should be well, whereas if the mastoids are allowed to become emergencies, the operation is done late, and merely regarded as a source of sepsis, the number we should have deaf out of 881 would be 77. This remarkable difference shows the improvement treatment always gives.

There is one group marked "normal ears". On inspection there is no history, no abnormality, and it was thought that some other factor, e.g. colds, etc., might be the cause of this deafness, and a second test was done. Here 69 cases passed, and we must conclude that in this group, one-half to two-thirds get better spontaneously. Thus we can say that by far the greater part of deafness in children of this city is due either to suppurative otitis media, and its sequelæ, or to obstruction of the Eustachian tube and similar conditions, and is remediable.

Owing to the outbreak of hostilities and the cessation of this work, a follow-up has not been possible, but we are left with certain outstanding points.

Looking first of all at those cases which have received no ear and throat treatment, we are struck by the fact that out of 881 cases, over 600 are in the categories of deaf and dry—i.e. those which would not have been taken to the doctor with running ears. They are the results of suppuration which has ceased. Here are 261 cases where the ears have been running and have dried up, but despite this apparent natural cure they have a fairly grave disability.

The same remark applies to the 295 retracted drums. Here another process has occurred, but the net result is the same, a loss of function. It would seem quite obvious that this is a clear and distinct proof of what has so often been said, and so much disbelieved, that the otoscope is no guide whatever to function after an ear is dry.

In the cases treated the main group as shown lies in active disease. These children came for treatment because the disease was more severe, accompanied by pain and discharge, and numbered 470 cases. 28 of these have dried up, and are still deaf, and many may have to have radical operations, or some other kind of surgery, but their hearing will probably not be good in the end.

It was my intention to make this paper merely a survey of what is happening apparently in many cities under the existing conditions, and the result is far from satisfactory. The majority of these cases are avoidable, if only we can bring home to the profession and the public that a case of otitis media is a case of potential deafness, with the resultant economic disability therein entailed.

**Mr. James Crooks:** Generally speaking chronic otorrhœa has its origin in acute otitis media, and acute otitis media has its origin in infection of the upper respiratory tract; and apart from congenital nerve deafness and deafness following one form of meningitis or another one rarely comes across deafness in the child which is not ultimately attributable to the state of the nasopharynx.

For these reasons if we are to discuss usefully prevention of chronic otorrhœa and deafness we must concentrate on the nasopharynx.

Not only is the initial acute ear disease the result of infection in the upper respiratory tract, but the presence of an infected focus in that situation is the common cause of the deplorable sequence of chronic otorrhœa from acute otitis media. If all acute otitis were subjected to treatment, and if that treatment were always successful, chronic otorrhœa would not exist and deafness in childhood would be rare.

The third section gives the number of ears which are affected according to the loss of acuity in decibels. Column A shows that nearly 23,000 hear fairly well, i.e. -3 to +6 decibels, but that 845 had a greater or lesser degree of deafness, 286 were very deaf. 415 were sufficiently deaf to make education quite difficult, and 144 could hear with great difficulty. This is quite a large proportion.

When these children failed in their tests the parents were interviewed, and the children examined by the aural specialist, in this case myself. Each case in these series I have examined personally.

The second table is a diagnostic one. The headings under which these cases are

TREATED EARS				UNTREATED EARS			
Infected ears—							
Attic disease	...	...	14	Attic disease	...	...	4
Subacute otitis media	...	...	17	Subacute otitis media	...	...	16
Ch. suppurative otitis media	...	...	470	Ch. suppurative otitis media	...	...	29
Chronic mastoid	...	...	46	Chronic mastoid	...	...	0
Mastoids, post-op.	...	...	19	Mastoid, post-op.	...	...	81
Healed otitis media	...	...	28	Healed otitis media	...	...	261
Polypi	...	...	36	Polypi	...	...	...
Non-infected ears—							
Eustachian obstruction	...	...	5	Eustachian obstruction	...	...	31
Other causes	...	...	2	Other causes	...	...	...
Wax	...	...	316	Wax	...	...	295
Retracted drumheads	...	...	26	Retracted drumheads	...	...	...
Foreign bodies	...	...	10	Foreign bodies	...	...	...
Normal ears	...	...	4	Normal ears	...	...	109
Not diagnosed	...	...	26	Not diagnosed	...	...	64
1,019				881			

classified are arbitrary, and I have chosen the 14 groups as wide, general classifications, sufficient for the analysis, and open to some criticism as to the nomenclature and perhaps pathology. The left-hand column shows the type of disease. The numbers down the right-hand side are the total numbers of children. If we take the largest groups we find that out of 1,019 children, 470, nearly one-half, are deafened from chronic suppurative otitis media, 316, just under one-third, had wax in their ears, which caused the greater part of their deafness, but when this was removed one-third of these still had remaining deafness.

Chronic suppurative disease of the active type was by far the commonest cause of deafness, and with suppurative otitis media, the subacute type and the chronic attic disease, and definite chronic mastoids and polypi, accounts for over one-half of the total cases of deafness.

It would here be wise to explain the two groups, infected and non-infected. The term "non-infected" means in the main that no suppurative process has been observed in the ears, no visible scars were left, and no history obtained of suppuration. Of these cases there were 389 out of 1,019. Foreign bodies were few in number. Healed otitis media accounts for 28, healed mastoids for 19, polypi, which really can be classed as chronic suppurative otitis media, or mastoiditis, for 36. The classification "not diagnosed" mostly consisted of various types of inner ear deafness, or transitory cases which were temporarily deafened from some cause not ascertained at the time. There were 26 of these in 1,019 cases.

Over one-half of the cases of deafness here presented might be prevented by early and proper treatment, and these figures show that if the problem is attacked from the right angle, and at the right time, it is a most promising field of investigation and cure.

If we take the large, untreated group of 295 cases out of 881, which are put under the heading "Retracted Drumheads", we see that it is a very much greater proportion in these cases than in the 26 out of the 1,019 treated. This means that in treated cases retracted drumheads are a comparative rarity compared with those in untreated children. The treated children have had all kinds of treatment, i.e. their tonsils, their adenoids, or concomitant disease, if present, have received attention. They have been out into the country, and have received the very best attention from their doctors who have worked in close co-operation. The net result is extremely good. It is a figure of 26 against 295. Some of these 295 retracted drumheads get better because the causes are transitory, and during second testing some months later 150 were very much improved, but if we assume the whole of these get better it still leaves 145 as against 26 in the treated group. This shows clearly the necessity for general treatment in addition to local treatment, and the efficacy of this treatment.

Turning now to the question of deafness after mastoid operations, excluding radical ones, in the 881 non-treated cases there appear 81 who have had mastoid operations. These were emergencies, and had not been treated in any way for their loss of function. They were done at various institutions, and are a cross-section of the results from many sources. The proportion is roughly 10% of the whole group. In the children treated, the number of post-operative mastoids that were deaf was only 19, and these had received special consideration for their deafness by one surgeon.

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Not only is the initial acute ear disease the result of infection in the upper respiratory tract, but the presence of an infected focus in that situation is the common cause of the deplorable sequence of chronic otorrhœa from acute otitis media. If all acute otitis were subjected to treatment, and if that treatment were always successful, chronic otorrhœa would not exist and deafness in childhood would be rare.

Obviously there comes a stage, say with bone infection, when the establishment of a healthy nasopharynx will not suffice to cure disease in the ear, but at no stage, even after a radical mastoid operation has been performed, can the condition of the nose and throat be neglected, for, in such a case, if infection is still present, not only will the other ear be in jeopardy, but recurrent infection of the Eustachian tube leading to the radical cavity may give rise to troublesome discharge from that ear.

I have analysed for the purposes of this discussion the condition of the nasopharynx in the last 50 children who have been in my ward for the treatment of middle-ear deafness or recurrent or chronic otorrhœa. The condition of the adenoids has, in all cases, been confirmed by examination under anaesthesia, and X-ray films of the nasal accessory sinuses of each child were made. Behind these observations lies the much more complex problem of resistance to infection and of environment. For example it is obvious that a child may have a naturally healthy nasopharynx, or may have attained such a condition by the aid of medical or surgical treatment, but still be subjected to severe and recurrent infection from his mother who gets tonsillitis or has a chronic sinus infection. Or the child may suffer from repeated infections because of lack of immunity, or be subject to continual catarrhal nasopharyngitis as a result of malnutrition or poor hygiene. Our study of the prevention of deafness and chronic otorrhœa should therefore start further back than the customary realm of the ear, nose and throat surgeon.

But to return to the gross observations and treatments which are within our scope, and by which we can improve the state of the nose and throat so that the ear, in its turn, may benefit, not only is disease of the adenoids, and to a lesser extent disease of the tonsils, associated with disease in the ear, but also ear disease and sinus infection are closely associated. Though we realize the significance of sinusitis in the adult, we have been slow to acknowledge its frequency in childhood. Even on theoretical grounds it is likely to be common in the early years, when upper respiratory infections (including the infectious fevers, of which whooping-cough is a frequent cause of sinusitis) are more prevalent than in later life. Ear infections are admittedly more common in childhood than in adult life, and the genesis of infection in a sinus is the same as that of the ear. In every case of ear infection the condition of the sinuses must be investigated. An X-ray film will often reveal disease in a sinus which would not have been suspected on clinical grounds. Of course not every opaque sinus is full of pus, or even muco-pus, and marginal opacity may be merely local evidence of generalized swelling of the mucosa of the upper respiratory tract, which would call for general treatment rather than treatment directed primarily towards the sinuses.

Of the 50 children who were admitted to my ward with obstinate or complicated ear diseases 34 had catarrhal and recurrent otitis media and 16 had chronic suppurative disease. Of the first group 12 had tonsils and adenoids present, and it was disappointing, reflecting as it does upon surgical technique, to find that 17 others had adenoid remnants; 15 had radiological evidence of sinus infection, and in 8 of these pus or muco-pus was washed out of the antra, in some cases on numerous occasions; while in only 2 was the condition of the nasopharynx and sinuses healthy, if we exclude those whose tonsils and adenoids were present but may have been apparently normal. While of the 16 children with chronic suppurative otitis the tonsils and adenoids were present in 4, adenoid remnants in 8, and the sinuses were infected in 3. There was no obvious focus of infection in 3.

It was considered advisable to remove the tonsils and adenoids of all the children. Adenoids are such a frequent cause of ear trouble and vary so much in size and condition from time to time that I would find it difficult to say with certainty that adenoids could safely be left in any child with otitis media.

The adenoid remnants which were removed were often of very considerable size, sometimes huge, and containing accumulations of caseous matter. In my experience adenoid remnants give rise to much more trouble, both in the ears and in the nasopharynx, than do virgin adenoids of the same size. Particularly harmful to the ears is the hypertrophied lymphoid tissue which is so often left at the sides of the nasopharynx. It has to be admitted that the difficult operation of removal of adenoids is often very inadequately performed, with serious consequences to the ears.

Captain E. P. Fowler, Jr. (United States Army) said that in the treatment of otitis media the question of sensitization to the sulphonamides was important. This was very troublesome if it became necessary to give the drugs a second time. It had been found,

particularly with sulphathiazole, that something like 37% of patients who had previous doses for any disease develop a sensitivity. He therefore reserved sulphonamides for meningitis, lobar pneumonia and other serious diseases, rather than using it routinely for ordinary otitis. He knew of one case in which sensitivity lasted for two years.

In America phonograph audiometer routine testing and examination was started in 1920-21, by E. P. Fowler, Sr., but a great deal of apathy had to be overcome. In New York 800,000 children were tested for three years. It was discovered that there was even an economic gain. In addition to the advantage of having children start out in life without the handicap of deafness, which made them appear stupid, it was found that the cost of sending technicians to the schools to test the children was less than the cost of having these same children repeat their classes year after year because they could not hear the teacher. The testing actually saved money for the Board of Education.

Incidentally there was a seasonal incidence of changes in hearing. It had been found that the audiometer readings were better in the spring and summer. Apparently in the summer the adenoids were less swollen so less deafness occurred. The experience might not be the same in the different climate of Great Britain.

He had tried to deal with the adenoid remnants which had been mentioned by Mr. Crooks. It was often impossible to remove the most important of these tiny remnants by surgery, and he had seen serious results caused by eminent surgeons who had been too radical in removing them surgically. He now followed the method of Crowe of John Hopkins who irradiated the nasopharynx in order to treat whatever was left in the adenoid region after an ordinary adenectomy was done. He had done this in three different ways, but the simplest and easiest was to use a small capsule of radon gas which was put into an applicator the size of a nasopharyngoscope and slid through the nose into the nasopharynx. With 250 millicuries eight minutes' application to each side of the pharynx were necessary. Usually three to four applications at five to six weeks' interval were enough. Larger quantities of radon saved time but were proportionately dangerous to the operator.

It had been suggested that the same results were obtainable with deep X-ray therapy, and accordingly he carried out a series of cases with that method, but it proved to have certain disadvantages. One of these disadvantages was that the patients had to come several times a week to get their treatment, and there was also the danger of treating other tissues than the ones it was desired to reach. Later he had worked out a method for the employment of small quantities of radium to replace the radon as given by Crowe. The time was longer but the total dosage of 66 mg.hrs. per treatment was the same. Small children might be given an anæsthetic before the radium or radon was put in, and they were then examined with the nasopharyngoscope. He commended that type of treatment and thought it well worth while for the prevention of recurrent otitis media and its consequent deafness.

Dr. J. Alison Glover said that chronic middle-ear suppuration in school children was mostly found in entrants and diminished during school life year by year. Its frequency had steadily fallen. Thus in London it had been found in 3.7% of children examined in routine medical inspections in 1911; in 2% in 1920; in 1% in 1930; in 0.8% in 1935; in 0.6% in 1938, and in 0.3% in both 1940 and 1941. The incidence was thus only one-twelfth of what it was thirty-one years ago.

It was definitely a "poverty" disease owing to the higher incidence of acute otitis media due to the earlier age incidence of measles and other infectious diseases of childhood in poorer families; and their environmental conditions, e.g. overcrowding, and sleeping more than one in a bed, leading to higher hæmolytic streptococcal carrier rates and greater liability to respiratory complications.

There was also a greater tendency for acute otitis media to become chronic due to the delay in securing and maintaining treatment, as less importance was attributed to the "running ear" by the poorer parents; to neglect of nasal hygiene; and to partial dietary deficiencies, particularly of vitamins A and C.

Apart therefore from local treatment, and treatment for associated conditions (particularly sinusitis), the indications for general treatment seemed to be an open-air regime, preferably residential, correction of nutritional deficiencies, and the postponement of measles to as late an age as possible by such schemes as the London measles scheme. The education of parents in the importance of the "running ear" and the need for early treatment was fundamental to the prevention of chronic middle-ear suppuration.



Just before the war the Board of Education published the report of the Committee of Inquiry into Problems relating to Children with Defective Hearing (H.M. Stationery Office, 2s. 6d. net). Owing to the war the Board had been unable to implement the recommendations, which, he was sure, would be found satisfactory by the Section, and which would meet most of the constructive suggestions made during the discussion.

Dr. J. N. Dobbie (Public Health Department, L.C.C.) said that Dr. Alison Glover in his recent Chadwick Lecture had pointed out how the School Medical Service in dealing with otitis, had proceeded from ascertainment to treatment and finally to prevention. It was necessary to go back quite early to see where the origin of these ear troubles lay. The range of treatment was wide, and special attention should be paid to this subject in the medical curriculum so that some consistent approach to the problem might be made. Prevention called for much more study. The parents must be educated by the doctors themselves. Students should be taught that it was of little use looking to treatment only without regard to real causes, such as home and social conditions.

During the last three years there had been an enormous evacuation of London children to the country where at least they had the advantage of more open air. At the beginning of 1942 the L.C.C. school doctors—and 75% of this work was done by general practitioners—said that they had been particularly impressed when examining the children during 1941 with the statistically significant drop in the incidence of ear disease. The only reason he could assign to it was that these children had had for the first time in their lives a change of environment and an improved nutrition.

Mr. W. M. Mollison said that obviously education should begin at the child's first year, for the bulk of these cases took their origin in the years between birth and 5. Recently he had seen a good many recruits for the Services who had been rejected because of running ears, and it had been brought home to him that between school-leaving age at 14 and entering national health insurance they had received no treatment.

Mr. J. C. Hogg said that during the past twelve years he had been aural surgeon to elementary school clinics on the outskirts of London, and for seven years he had been seeing cases referred from the welfare centres run by the urban district council. It was found that the incidence of otitis media had considerably decreased among the elementary school children of that area. The mothers were becoming educated to take their infant children to the welfare centre for advice, and again in many cases the medical officers attached to those welfare centres were now on the lookout for otitis media. They referred such cases to the school centre, where they were examined, and he was glad to say that he did not believe that there had been during the last seven years any cases of acute otitis media among infants which had failed to respond to conservative measures. In this particular school centre the children were examined by the assistant school medical officers on entry, that is, at the age of 5, when they were sorted out, and all ear, nose, and throat cases were referred to a specialist. They were examined again at the age of 10, and the cases which called for such a course were referred again to the specialist, and at the school-leaving age they were once more examined and referred if necessary.

He agreed with Mr. Mollison that the gap between school-leaving age at 14 and the age at which these persons became eligible for the Services was a serious one. The records of the militia boards showed that these cases had had treatment at school, but nothing had been done since leaving.

## Section of Neurology

President—R. M. STEWART, M.D.

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### Vital Staining in Brain Surgery. A Preliminary Note

By ARNOLD SORSBY, F.R.C.S., A. DICKSON WRIGHT, M.S., and ARTHUR ELKELES, M.D.

**Mr. Arnold Sorsby:** Acid dyes such as trypan blue stain all the tissues of the body but fail to reach the brain, being immobilized in the choroidal plexus. Attempts to obtain staining of the brain failed with all but the basic dyes (Friedemann and Elkeles, 1931a, 1931b, 1932, 1934) which, however, were highly toxic. Elsewhere (Sorsby, Elkeles and Goodhart, 1937; Sorsby, 1939, 1940) an account has been given of the experiments leading up to the use of amphoteretic dyes such as Kiton fast green V in attempts to induce staining in the intact animal, the work being undertaken in the first place with the object of inducing staining of the retina in life. Staining of the brain was obtained and staining of the retina was noted in animals whose retina had first been damaged experimentally. In assessing the efficacy of a dye it is necessary to bear in mind that lack of staining does not necessarily imply that the dye has not reached the tissue, for the dye tends to be reduced to its leuco-base at different rates by different tissues.

It seemed feasible to use the dye as a contrast staining medium in the course of operations on patients, particularly where sharp demarcation in the field of operation is not present and may be desirable surgically.

**Mr. A. Dickson Wright:** *Clinical Experiences.*—Kiton green (30-50 c.c. of 10% solution) was used in the five cases of operation, four of whom were under local anaesthesia, and only one seemed to have any general reaction and that took the form of a short loss of consciousness with mild tonic spasms which quickly passed and did not return. Immediately on injection the skin starts to turn a vivid green and the blood a tawny brown. The muscles have a similar colour to the blood but the white structures, bone and dura, stain vividly, the dura much more so than the bone, so it might be inferred that meningiomata would stain well. At the moment of injection the brain undergoes a sudden darkening of colour as if a cloud had passed beneath the sun, owing to the change in the circulating blood and possibly at this moment a faint greenish coloration of the convolutions is seen momentarily. This quickly fades away and so does the change due to the colour of the blood as the dye becomes fixed in the body tissues. The brain soon regains its normal appearance except for any pathological condition which takes up and holds the dye. Certain small green haloes were seen on the convolutions of two patients both of whom were sufferers from Jacksonian epilepsy. These haloes were about  $\frac{1}{4}$  inch across and clear in the centre. The skin colour persists for two or three days after operation and does not produce any discomfort in the patient.

The question arises as to whether the blood brain barrier is operative for neurones, macroglia and microglia alike, or is it possible that one of the tissues may be exempt. It would be reasonable to imagine that the mesoblastic microglia corresponding to the defensive cells of the rest of the body might be expected to cull more from the capillary blood than the other cells of the brain and so accumulations of microglial cells formed in response to infection or injury might be expected to stain well and there is reason to believe this to be so.

The macroglia takes part in the formation of scars and inflammatory reactions so possibly it may also show affinity for dyes which do not penetrate the neurones. The glial cells also have feet which are closely applied to the blood-vessels. In gliomatous tumours areas of necrosis or haemorrhage may provide leaks in the blood brain barrier and permit staining of the tumour. It is well known that thorotrast is sometimes arrested in the sinusoids of

a glioma. In this research we have not been able to demonstrate convincingly the regular staining of gliomata. In one case this was probably due to the great vascularity of the tumour because the cut surfaces turned a vivid green when incised with the diathermy needle so apparently the tumour was holding a good deal of the dye. The exact definition by staining of the extent of a mural nodule in a cystic glioma might be a valuable technical adjuvant. The neuro-surgeon is often at a loss to locate the area of tumour tissue in a cystic glioma. We did not experiment with viewing the brain in a coloured light or through coloured glasses to eliminate the reds but it is our intention to do that on later cases and expect some interesting results.

The staining of meningiomata is a foregone conclusion although we did not apply the method in this series. The usually easy definition of these tumours makes the method redundant but possibly it might help in determining the extent of invasion of bone especially in tumour of the basis cranii.

The treatment of traumatic epilepsy by excision of cicatrices of the brain might be greatly facilitated by staining. No opportunity has occurred of applying the method in our cases. The appearances of the small green rings already mentioned in two epileptic cases (Cases 1 and 4) suggest a localized defect in the blood brain barrier as a possible cause of epilepsy, noxious or allergic substances in the circulation gaining access through these leaks to the neurones.

Angiomata could be relied upon to stain well and the treatment of cystic cerebellar angiomata might be greatly helped as a mural nodule could be more precisely excised.

CASE I was a man of 32 with a rapid progress of symptoms indicating a fast-growing glioma in the left motor area. He was operated under local anaesthesia, the dye being injected before the patient was draped. When the brain was exposed, the tumour was seen glowing like an emerald among unstained convolutions. It was easily and precisely removed and the patient made a good recovery and apart from a little clumsiness of the hand is well and working to-day. The excitement over this case did not die down until the pathologist's report arrived some weeks later. The tumour was a granuloma of unknown origin, such a case as one would not meet again in a lifetime.

CASE II was a man upon whom five years earlier I had performed a frontal lobectomy for a hard, cystic, spongioblastoma multiforme. He had remained well for five years, working in an aircraft factory, when his headaches returned with Jacksonian fits. The flap was reopened and in place of the frontal lobe was a large cavity containing crystal clear cerebrospinal fluid; projecting into this cavity were three large tooth-stools of recurrence which had a peculiar chocolate colour. The tissue was freely removed with the diathermy loop and then it was noticed that the cut surfaces glowed a vivid green showing that the dye was held by the tumour and only revealed when the blood was driven from the tissues by the diathermy current. This man has since died, deep X-ray therapy making no difference to his downward course, and autopsy showed tumour tissue streaming across the brain fornices and into the basal ganglia.

CASE III was a man of 53 who had had his kidney removed two years earlier for carcinoma, and now had a tumour in the occipital region. It was thought that an occipital lobectomy was a possibility as the secondary in this type of case is often solitary. Operation revealed this not to be so, multiple tumours being present. The coloration in this case did not seem to be of any value in defining the limits of the tumours which did not seem to take up the dye. The patient died within twenty-four hours and it was noteworthy that although the tumour masses were unstained, each was surrounded by a beautiful green margin of stained brain tissue.

CASE IV was a man of 31 with severe epilepsy, often but not always with a Jacksonian onset. He had an angioma of the sclera of the right eye and arteriography showed an arteriovenous aneurism of the brain. The nutrient and efferent vessels converged on an area in the cortex which corresponded to his motor starting point and it was felt that there might be a nucleus of hæmangioma which if excised would help him and it was thought that vital staining might help.

In this case the dye was injected after the cortex was exposed but no help was obtained, as no nodule of tumour tissue was seen; the largest of the anastomosing vessels were tied. In this case two small green rings were seen on the motor cortex. No benefit was obtained from this or from other procedures in this case and he remains severely incapacitated by reason of his epilepsy.

CASE V was a man of 52 with signs of a rapidly advancing glioma of the right hemisphere. Although it was realized that this was a hopeless case it was felt that useful information might be obtained by vital staining. Actually the operation was in no way helped and the alteration of colour on diathermy incision was not seen in this case. A good deal of tumour was removed but the patient did not improve and died after two days. Post-mortem showed a definite, light green staining of the considerable tumour still left behind with no staining of the brain.

*Comment.*—It is not suggested that vital staining should be a routine in intracranial operations but the use of Kiton green might often be of value in a difficult surgical situation.

It can be easily run in through the intravenous drip which is almost routine in neurosurgery nowadays. Perhaps for a little while the dye could be used more often than it is useful, so that more data can be collected because, although temporarily disfiguring, it seems to be quite harmless.

**Dr. A. Elkeles:** The interchange of substances between blood and brain has been studied in numerous animal experiments, but in order to apply these results to human pathology it was necessary to find clinically adequate methods. Elsewhere an account has been given of the use of Kiton fast green V both experimentally in the rabbit (Sorsby, Elkeles, Goodhart and Morris, 1937) and clinically (Sorsby, 1938, 1939, 1940) for vital staining of the retina. Kiton fast green V was well tolerated in animals even in very large doses, and this led to its clinical use. The present investigation aimed at establishing the feasibility of differential staining of normal and pathological tissue in the central nervous system—a procedure that might be helpful to the surgeon in defining the outline of tumours such as gliomas.

The assumption that contrast staining could be achieved was based on the following facts. It had been shown by Goldmann, that trypan blue an acid semi-colloidal vital dye stains the entire body of animals except the brain. Large single doses or repeated injections of highly diffusible acid dyes stain the cerebrospinal fluid under physiological conditions and may produce a faint staining of the grey matter of the brain, but even here the difference in comparison to other tissues and organs remains striking.

In contrast to the acid dyes Friedemann and Elkeles (1931, 1932, 1934) found that many basic aniline dyes and the chemically amphoteric alizarin blue S stain the brain. The spinal fluid examined at the same time, however, remained clear. These experiments proved that a direct interchange of substances between blood and brain exists, without the intermediary of the spinal fluid, and that the electrical charge of the substances decides to some extent their affinity or their lack of affinity to brain tissue. Basic dyes are very toxic, probably owing to the fact that they are stored in the brain, and for this reason they were not suitable for clinical investigations. If, however, sulpho groups are introduced into basic neurotropic dyes, they lose their neurotropic character and their toxicity. They behave like acid dyes.

Kiton fast green V is essentially a sulphonated basic dye and highly diffusible.

When 30 c.c. of this dye were injected intravenously in patients before or during the operation, the skin and the conjunctiva showed a deep green colour; the dura was stained, whereas the brain was practically uncoloured. In the following remarks attention is confined to the possible theoretical significance of three of the cases reported in full. The first case was dramatically successful. The tumour was stained, but the brain remained colourless. The microscopical examination proved the tumour to be granuloma. The explanation of this result lies in the fact that this tumour did not contain brain tissue, and as acid dyes have a special affinity for connective tissue, the granuloma was stained.

The second case was a glioma (spongioblastoma); its periphery was uncoloured, but the centre which had undergone marked degeneration showed some staining. The explanation for this result can be found in animal experiments. Acid vital dyes produce staining in those parts of the brain which have been severely damaged. This was also proved in our experiments when, after the injection of the dye, the cut surface of brain tissue severed by diathermy showed almost immediately a green coloration. We must assume that the actively growing part of the glioma not only retains its similarity to the original tissue in morphology, but also in function.

The third case was a hypernephroma with multiple secondaries in the brain. The secondaries were unstained, except for their peripheries showing a thin green ring. This observation seems to be of theoretical interest. Neurotropy and lipotropy are closely related to each other; that is to say, substances which have an affinity for the brain are also stored in fatty tissue. The hypernephroma is composed of a scanty stroma, some glycogen and a large amount of lipid, mostly cholesterol ester. This might be the explanation that the secondaries of the hypernephroma reacted to vital staining in the same way as brain tissue. The second and especially the third observation provide objections to the theory that the locus of the barrier lies in the endothelium of the intracerebral vessels. They rather suggest that affinity or lack of affinity of substances for living tissue depends to a great extent on their electrical charge and on the tissue constitution. One must agree with L. S. King, that no experimental proof exists for the assumption, that the endothelium of the cerebral vessels is different from the endothelium of other vessels in the body.

We have not succeeded so far in staining the invasive part of the glioma and it still remains to be seen how other brain tumours will react to vital staining. But the investiga-

tions make it probable, that pathological structures within the central nervous system containing connective tissue or marked degeneration will show contrast staining.

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## DISCUSSION ON MYASTHENIA GRAVIS AND THYMECTOMY

Dr. James Carson: Air Commodore Keynes has now removed the thymus gland from twelve patients suffering with myasthenia gravis. This is a brief statement of the results and of preliminary observations. It is only nine months since the first operation was performed and our investigation is necessarily incomplete.

The association with myasthenia gravis of a persistent or enlarged thymus gland is well known. Norris (1936) states that lesions of the thymus are described in half the cases which have been published. This figure, he says, probably expresses the frequency of gross abnormalities. He suggests that there is a constant and specific pathology which may be recognized only on microscopic examination. This change is a hyperplasia of the epithelial cells of the medulla which varies from that in which the normal structure of the gland is preserved to that in which there is an undifferentiated syncytial mass of epithelium obliterating the round cells and Hassall corpuscles, and in structure closely resembling the foetal thymus. Schridde (1913) on the other hand states that they are the predominant cells in tumours of the thymus not associated with myasthenic symptoms and that thymic tumours found in myasthenics consist mainly of the round cells of the cortex, which he regards as also of epithelial origin.

A detailed histological study of our specimens is not yet complete. The sections show thymic tissue with well-preserved medullary structure, few Hassall corpuscles and little or no cortex—like the appearances described by Norris. They differ from each other only in the degree of epithelial hyperplasia. This does not correspond in any way with the results of treatment. A gland which was chiefly made up of large sheets of medullary epithelium was from a patient whose condition was not altered by operation.

The weights of the glands range from 7.5 to 31 g. Blalock and his collaborators (1941) do not give weights but comparison of measurements suggests that they are similar to those of our series. There is no correlation between weight and age, length of history or clinical improvement after operation. These glands are well-defined structures but it is not possible to state without further investigation whether they are abnormal, for there is no agreement about the weight of the normal. According to Hammar, whose figures are much quoted, it is approximately 25 g. in the age-group 18-44 years of our patients. Schridde states that the weights given by Hammar are much too great. He found from examination of the glands of healthy persons who had been killed that the maximum weight of 25 g. is attained at 15 years of age. Then there is rapid diminution until at 30 years the remains of the thymus cannot be weighed. He says that if at this age there is recognizable and measurable parenchyma which is found microscopically to be thymus, the thymus is pathological.

There are recorded a number of attempts to treat myasthenia gravis by thymectomy and in our series twelve patients (5 male and 7 female) aged from 18-44 years have been treated. The duration of illness ranged from seven months to ten years. Every patient was severely affected and before operation was unable to work even with the help of prostigmin. All had the characteristic weakness and rapid fatigability of external ocular, facial, palatal and pharyngeal muscles, of neck, trunk and limb muscles. All showed great increase of power in the affected muscles after administration of prostigmin.

Harvey and Lilienthal (1942) have shown that when  $\frac{1}{2}$ -1 mg. of prostigmin is injected into the brachial artery, the hand muscles of the non-myasthenic become weak and fasciculate for some seconds. In the myasthenic, strength is maintained, or, if previously diminished, increased, and there is no fasciculation. After thymectomy there is a change from the myasthenic toward the non-myasthenic reaction corresponding in degree with

the amount of clinical improvement. The myasthenic patient in complete remission, it is stated, gives a myasthenic reaction. In most of our cases this test was carried out before operation and in each power was maintained or increased.

Three patients died after operation. Three have recovered and remain well nine, six and three months after operation. They lead normal lives. They do not require prostigmin. Pathological fatigability of the previously affected muscles cannot be demonstrated. Before operation intra-arterial injection of prostigmin produced a myasthenic reaction. Two have been tested after recovery. Extreme weakness of the hand muscles resulted, but there was no fasciculation.

Three have improved.

The first was treated a year ago by X-ray irradiation of the thymic area. The immediate result was a severe exacerbation of symptoms, but later she improved and was much better after this treatment. Before operation and without prostigmin, speech was slurred and quickly became unintelligible. She had troublesome double vision. She had difficulty in chewing and in swallowing and, towards the end of a meal, she had to support her lower jaw. The facial muscles were weak. She could not raise her arms from her sides. There was a good response to prostigmin. There was no alteration in the strength of the hand muscles, which were not affected, after intra-arterial injection of prostigmin. Five months after operation she develops, after about a hundred words, slight dysarthria, which does not then become worse. There is slight weakness of her facial muscles. She can raise her arms from her sides against moderate resistance. She has reduced her prostigmin dosage from 135 to 30 mg. daily. After  $\frac{1}{2}$  mg. of prostigmin subcutaneously the dysarthria does not develop and the facial movements are full but there is no other effect. Intra-arterial injection produces gross weakness of the hand muscles.

The second patient was thyrotoxic. After subtotal thyroidectomy his myasthenia became worse. Before the thymus was removed he was helpless without prostigmin. He could not even raise his head from the pillow. His speech was unintelligible. He could not swallow. With 150 mg. of prostigmin daily by mouth and 1 mg. subcutaneously before meals he could move about in bed, sit up and swallow with difficulty. He had frequent attacks of severe dyspnoea. He has had no dyspnoeic attacks since operation. Now, four months after operation, without prostigmin, his speech is normal and does not become slurred or nasal. He has no difficulty in swallowing. He can sit up without effort and can walk several hundred yards without fatigue. Muscular power is below normal, there is some fatigability and definite improvement after prostigmin. The present optimum dosage is 45 mg. daily. Intra-arterial injection produces some increase in strength of the hand muscles.

The third patient suffered from ptosis and diplopia, facial weakness and slurring dysarthria. She could not, without prostigmin, sit up or raise her head from the pillow against slight resistance. She could not raise her arms from her sides or extend her forearms, hands or fingers. Other movements of the upper limbs were weak. There was a good response to prostigmin. Eight weeks after operation and without prostigmin there is no ptosis. Speech is normal and the facial movements full. She can sit up without difficulty and can raise her head against moderate resistance. There is slight weakness of extension at elbows, wrists and fingers, and some fatigability. Other movements of the upper limbs are of normal strength. The strength of the weak muscles is increased when prostigmin is given.

One patient I have not seen since operation, but slight and definite improvement is reported.

In two cases, five and two months after operation, there has been no change.

In the cases which have responded to treatment most of the improvement has occurred by the time that the post-operative period is over. Then there is gradual progress during the next six to eight weeks. It was within these limits of time that prostigmin ceased to be effective in the patients who have recovered completely.

X-rays of the anterior mediastinum of our patients were taken from various angles but no shadow corresponding to the thymus was seen.

Extracts were made from one gland removed by operation and injected into intact animals by Dr. McIntosh of the Medical Research Council Institute. No muscular weakness developed.

Kinnier Wilson states that at earlier stages symptoms come and go to a certain extent and remissions are not infrequent but later most of the clinical phenomena become fixed. Such is our experience. One of the twelve patients had a remission which began three months after the onset of the illness and lasted for four years. Another recovered and remained well during pregnancy. Apart from those incidents all had become steadily more incapacitated. In one among nine cases collected by Wilson and Stoner in Sheffield (to be published later) a remission occurred after a few months' illness and lasted for five years.

Our results and those published by Blalock and his colleagues indicate that extirpation

of the thymus offers some prospect of recovery. We have found no distinction, clinical or pathological between the cases which recovered and those which did not improve. Anatomists agree that in some persons there are accessory thymus glands situated behind the thyroid. It is possible that all the thymic tissue has not been removed from the patients who did not recover.

Myasthenia gravis and hyperthyroidism occur together more often than can be explained by chance. Kowallis and others (1942) have recently collected 15 case records. They describe one case in which both conditions were cured by subtotal thyroidectomy. No thymic tissue was found when the mediastinum was explored.

Three of our twelve patients had thyrotoxicosis. In one a subtotal thyroidectomy was carried out. His myasthenic symptoms became more severe. Six weeks later the thymus was removed. There was definite improvement of the myasthenic symptoms. Another patient from whom a toxic adenoma of the thyroid was removed when the thymus was taken out remains thyrotoxic but has no symptoms of myasthenia.

Most of the patients investigated were in the care of the Physicians of the National Hospital, Queen Square. To them, and especially to Dr. Gordon Holmes and to Dr. E. A. Carmichael, I wish to express my thanks.

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**Air Commodore G. L. Keynes:** Attempts have been made in the past to remove the thymus through an incision in the neck, but it is quite clear that this could only effect an incomplete removal of the gland, which extends far beyond the reach of a finger introduced from above. There can be no doubt that full exposure of the mediastinum by splitting the sternum down the centre as far as the fifth rib is absolutely necessary. The skin incision consists of a rather short and low collar incision above the sternal notch, and a long vertical incision over the centre of the sternum as far as the level of the fifth rib. The suprasternal notch is exposed by blunt dissection, and the slender horn of each thymic lobe can then usually be seen almost or quite reaching the lower border of the thyroid isthmus. The interclavicular ligament is divided, and a passage is cleared behind the sternum by introduction of a finger as far as it can reach. The sternum is then split by means of a suitable instrument, and cuts are made in the bone outwards into the fourth intercostal spaces on either side. The two sternal flaps are raised outwards, and are held in position by a strong self-retaining retractor. The layers of fascia covering the thymus gland are then divided in the mid-line, and the yellowish-pink thymic tissue is brought into view. It may, I think, be assumed that the thymus gland will be found to be enlarged in every patient with true myasthenia gravis, and a bilobed structure must be identified and completely removed. The gland varies greatly in its shape and size, its weight in our twelve patients ranging from 8 to 31 g., but its general pattern is constant. The left lobe is always found to be almost completely covered by the pleura of that side. The right lobe is more easily seen, but spreads out below over the pericardium and this part often reaches below the level of the fifth rib. Usually a large vein passes from the right lobe directly into the innominate vein. It is sometimes very difficult to secure adequate hæmostasis, and the separation of the very thin pleural membranes from the gland on each side without opening them is an exceedingly difficult manoeuvre, though it can usually be achieved if sufficient time be taken over it. The removal of the gland will sometimes be complicated by the presence of a thymic tumour. This was found in two of our twelve patients. In each it was closely adherent to the pericardium on the right side, and was incorporated with the pleural membrane, which had to be widely opened in order to remove the tumour.

We have some evidence that thymic tissue is not necessarily restricted to the anatomical confines of the thymus, but may spread to a varying extent in the mediastinal fat. This would afford an explanation of the uneven results that seem to follow thymectomy. But of all this it is yet much too soon to speak. It may be a far more complex problem than appears at first sight, and "the pathology of the living" may again serve to throw light on corners of physiology that have hitherto remained dark.

The anæsthetic is an exceedingly important part of the operative problem. Owing to the fact that our first patient was thyrotoxic, she was given our routine of rectal avertin with

gas and oxygen, and four other patients were treated in the same way, or with cyclopropane. Later we decided that avertin was undesirable in myasthenic patients, because we wanted them to recover full consciousness as soon as possible so as to restore normal respiratory movement and coughing. The last seven patients of the series have been given intratracheal cyclopropane by Dr. Frankis Evans. It is, of course, essential to have completely controlled anaesthesia since there is a risk of, and occasionally the necessity for, opening the pleura on one or both sides. The operation is not easy, but it is during the post-operative period that the greatest difficulties are liable to arise. The myasthenic patient is peculiar in that the respiratory and coughing muscles are sometimes severely affected by the disease. Thus, they are liable to respiratory crises quite apart from operation, and this tendency may become accentuated after the severe surgical interference necessitated by thymectomy. The patient can be assisted by posture (head-down position) continuous suction from the pharynx and larynx, and occasionally by an oxygen tent. At the same time, morphia, atropine, and prostigmin have to be given in suitable doses at the right intervals, and for three days or more there may be grave anxiety. One of our patients was suffering from a severe primary toxic goitre as well as profound myasthenia, so that a subtotal thyroidectomy had to be done before the thymectomy could be attempted.

The mortality of three out of twelve patients is heavy, though not perhaps heavier than was to be expected in the surgical treatment of so severe and obscure a disease as myasthenia gravis. I would like to emphasize the fact that only patients suffering from clear-cut signs of myasthenia in a severe or very severe degree have as yet been subjected to operations, so that the maximum hazards have been challenged. There are many patients with minor degrees of a myasthenia which appears not to be progressive, and we would not at present urge that these should be submitted to operation. On the other hand, I believe that the results so far obtained by thymectomy for the severer forms of the disease are encouraging enough to warrant further cautious trial, and we hope to present fuller and more extensive evidence of progress at some future date.

Dr. Russell Brain said that thymectomy had been performed upon three of his patients with myasthenia by Mr. Galloway. Their ages were 54, 37 and 45 and the duration of their illnesses was three months, six years and nine years respectively. He was not convinced that the operation had benefited them. He pointed out that ophthalmoplegia associated with thyrotoxicosis might be due to three causes—(1) thyrotoxic myopathy, (2) exophthalmic ophthalmoplegia or (3) myasthenia gravis.

Mr. R. L. Galloway: In order to perform such an operation as exploration of the thymus gland, Dr. Greenfield and I had to devise an instrument for splitting the sternum longitudinally from the sternal notch to the xiphisternum. The difficulty was to do this without injuring the fine parietal pleura behind the sternum in its middle third or thereabouts. I practised the operation on 8 successive cadavers. In the first 4 cases the pleura on one or both sides was ripped open. A button was mounted on the end of the instrument and a method of guiding the instrument was determined so as to keep it close to the posterior surface of the sternum. In the last 4 experimental operations the pleura was not in any way injured. It was then found easy, after distraction of the two halves of the sternum, by means of an adapted bladder retractor, fully to expose the whole of the mediastinum throughout its length, and completely to dissect out the remains of the thymus gland and the fat around it in each case.

It was now considered safe to undertake the operation on the living.

The parietal pleura was not injured and I have been able easily and rapidly to excise the complete thymus in each of the 3 cases, and to explore all round for any aberrant tumour or portions of the thymus. None were found in these three cases. Anaesthesia presented no great difficulty, and was administered by intratracheal intubation, using gas and oxygen. The patients had been specially prepared with prostigmin before the operation, so that they arrived on the operating table while that drug was producing its maximum effect. The duration of the operation in the first case was sixty-eight minutes from start to finish, and was reduced to fifty-eight minutes in the last case: this without hurry or stress in any way. Each of these patients stood the operation well and had completely uneventful surgical recoveries. In 2 of the cases where the thymus seemed to be heavier and more massive than usual, for two or three days immediately following the operation the patients seemed to be much better as regards their myasthenic symptoms. Whether this was an actual fact or whether it was due to suggestion produced in the patient by the operation I cannot say, but from what Dr. Russell Brain has said, this operation of removal of the



thymus gland, in no way changes the myasthenic condition so far as our observations have gone.

The operation is, of course, at present purely empirical and we have not yet got a proper explanation as to why thymic tissue should influence the proper correlation of function of nerve ends and muscle fibres. Since we have found that the operation can be performed with a high degree of safety, a low degree of post-operative morbidity and, so far as we have gone, with no mortality, it should be worth while continuing to do these rather empirical and extensive biological experiments.

The operation should be performed with accurate celerity, for if a long slow operation were carried out with the mediastinal pressure, &c., in long-continued unaccustomed decompression, a collapse stage might be arrived at in the operation, from which the patient could not recover.

[Three photographs were shown of the 3 glands removed which weighed respectively 20 g., 22 g., 28 g.]

**Dr. L. P. E. Laurent:** When myasthenia gravis and thyrotoxicosis co-exist they are to be regarded as parallel phenomena as Dr. Russell Brain has said; the evidence does not suggest that either of these conditions causes the other.

I have seen two cases of severe thyrotoxicosis in which typical myasthenic weakness came on suddenly within a week of death. In these cases dysphagia, dyspnoea, weakness of the limbs were all strikingly and repeatedly relieved by prostigmin.

I was interested to hear Dr. Gordon Holmes say that he had seen some good remissions after irradiation of the thymus. Amongst my cases followed over the past twelve years, four have done particularly well and they are the only four who have had X-ray therapy of the thymus. One of these patients, after two severe relapses with dyspnoea, had a complete remission lasting eight years and which still continues. Another severe case has kept well for some years apart from slight unilateral ptosis.

I have been struck by the great variation which exists from case to case in their response to prostigmin. A moderate dose may restore normal strength to a severe case, whilst a slighter case may show only partial improvement even on the largest doses. I wonder whether this observation might be of use in selecting cases for thymectomy. One would expect that the more striking the response to prostigmin the greater would be the patient's prospects of a remission.

**Dr. H. V. Morgan:** Failure of the muscles of respiration is one of the main risks of the operation of thymectomy. I have estimated the degree of involvement of these muscles by determining the vital capacity of patients with myasthenia gravis. The extent of the diminution in vital capacity is a measure of the degree of involvement of the respiratory muscles. Marked involvement endangers life and may be an indication for operation. Increase in the vital capacity occurs after exhibition of prostigmin, and the extent and duration of the improvement should be a measure of the risk of respiratory failure during the period of operation.

**Dr. S. P. Meadows** mentioned a group of cases of myasthenia gravis in which the manifestations were localized to one group of muscles, particularly the ocular muscles. The condition of the patients did not prevent them from living for many years, and they were frequently able to carry on a useful occupation, even without treatment. Secondly, remissions occurred in some cases of myasthenia gravis, particularly in the early part of the clinical course. These two facts should be borne in mind in selecting cases for operation.

The measurement of the vital capacity in cases of myasthenia gravis, as described by Dr. H. V. Morgan, might prove a useful aid to choice of cases for operation, as well as a standard by which the results of treatment could be assessed.

## Section of Comparative Medicine

President—A. FLEMING, F.R.C.S.

[October 21, 1942]

### DISCUSSION ON ACTIVE IMMUNITY. I.—GENERAL CONSIDERATIONS

**Professor Alexander Fleming:** Active immunity may be defined as the response of an animal to an antigenic stimulus. It is of importance to consider the nature of the antigen and in clinical immunization this consists of some preparation of bacteria or toxin. It may be:

I.—In the case of bacteria: (a) Living attenuated cultures. (b) Dead Cultures.

II.—In the case of toxins: (a) Active toxins. (b) Toxoids.

Living cultures and active toxins may be considered together. All Pasteur's work on immunization was carried out with living bacteria and there can be no doubt that it was successful. In the same way the earlier work on diphtheria immunization was carried out with active toxin (mixed with antitoxin) and it was likewise successful.

Pasteur's work was almost entirely on animals and the records of anti-anthrax inoculation show that, while immunity was conferred on the great mass yet in individuals the vaccine apparently induced the disease. This may be worth while in cattle, where the problem is purely economic, but if the same thing happened in man the sentimental considerations of the disaster would be calamitous. We have seen what has happened in recent years from the use of living attenuated vaccines and active toxins in man. In Lubeck many children died of acute tuberculosis following prophylactic inoculations of a living tubercle vaccine; and children have died from injection of toxin-antitoxin mixtures. It is quite true that in Lubeck it was shown that the children were inoculated, not with the attenuated "B.C.G." strain, but with a virulent tubercle culture, and that in the diphtheria toxin-antitoxin disasters there were mistakes in the preparation of the mixture, but we all know that mistakes will occasionally happen. Rightly, in my opinion, the authorities in this country have not sanctioned for use in man vaccines consisting of living bacteria, and I hope that this attitude will be maintained, for sooner or later if a living vaccine is issued—necessarily without preservative—a disaster will occur because of some human error, and such disaster will seriously set back the whole course of active immunization.

I have said earlier that as regards animals the problem is more one of economics, but I have little doubt that future work will show that everything that can be done with a living vaccine can equally well be done with a dead one, prepared rightly and administered in appropriate doses.

**Dead vaccines and inactivated toxins (toxoids):** Active toxins have almost entirely been replaced in clinical work by toxoids for the production of an antitoxic immunity such as is required against diphtheria, tetanus, and other diseases. The toxin is almost universally toxoided by exposure to formalin, which process does not denature its antigens, so that although it ceases to be poisonous it can still stimulate the production of specific antitoxins.

Vaccines have in the past generally been killed by heat at from 55° to 60° C., and it is with such heat-killed vaccines that the value of antityphoid, anticholera, or antiplague inoculation has been established. It has often been suggested that the bacteria constituting the vaccine should be killed by chemicals, and of these probably the favourite was formalin, on the assumption that any toxins present would be toxoided. There was little scientific backing for such a procedure, and recent work by Felix on typhoid antigens has shown that formalin has a definite deleterious action on the "O" antigen of the typhoid bacillus, which is definitely concerned with typhoid immunity, whereas heating to 60° C. or even higher leaves this "O" antigen intact. There is, however, another antigen of the typhoid bacillus—the Vi antigen which Felix maintains is also intimately concerned with anti-typhoid immunity—which is destroyed by heating to 60° C. or by formalin, which can be preserved by killing the bacteria with 75% alcohol. This alcohol-killed typhoid vaccine is at present under extensive trial.

It has been suggested that bacterial antigens of vaccines should be in solution instead of being contained in bacterial bodies and that if they were in solution the antibody response would be more prompt and complete. Vaccines so dissolved have been widely advertised and are, I believe, used on a considerable scale. There is, however, little scientific evidence to support them. On the other hand, we have in diphtheria toxoid an antigen which is normally produced in solution and it has been conclusively proved that better immunity is produced in children when this antigen is deliberately thrown out of solution and

administered in the insoluble form of alum precipitated toxoid (A.P.T.). It has been estimated that alum precipitated toxoid is some 200 times as potent as the parent toxoid in solution. It is clear, therefore, that it is not necessarily an advantage to have the antigen in solution—in fact it may be a serious disadvantage.

*Mode of administration of vaccines:* The usual method is by subcutaneous injection, but they have been administered by many other methods.

I.—*Intravenous:* In laboratories it is customary to immunize rabbits for the purpose of producing an "immune" serum by intravenous inoculation of the vaccine. In this way there is a much better response of demonstrable antibodies.

Vaccines have frequently been administered intravenously in man but then they are usually followed by an intense general reaction—(protein shock). A dose of 500 millions of typhoid vaccine given subcutaneously may or may not give a general reaction with rise of temperature, but rigors are uncommon. A dose of 50 millions injected intravenously is usually followed in an hour or less by severe rigors and a temperature of  $102^{\circ}$  or higher. The results as regards antibody formation are better with the small dose intravenously than with the large dose subcutaneously, but the severity of the reaction precludes the intravenous route as a practical clinical method.

II.—*Oral administration:* In certain communities this method has been very popular owing to the ease of administration. Extensive observations have shown that in the enteric group of diseases some immunity can be established by the oral administration of vaccines, but it is not the best method.

III.—*Absorption by mucous membranes:* It has been shown that the antigens of vaccines and toxoids can be absorbed through the nasal mucous membrane, and attempts have been made to produce immunity by intranasal sprays of vaccine or toxoid. This method has, however, been little practised.

*Difference in response on the part of different individuals.*—It has long been known that different individuals and animals respond very differently to the same antigenic stimulus, and we shall hear later in the discussion from Dr. Hartley that in guinea-pigs diet has a very important influence. We have tested the antitoxic response of large numbers of patients who have been immunized with staphylococcus toxoid. In some patients it is impossible to raise the antitoxic titre to more than 1 unit per c.c., more usually it rises to 8 or 10 units, and occasionally a patient's serum contains 15 units of antitoxin per c.c. with the same dosage of toxoid. No observations have yet been made as to whether the individuals which give a poor response are suffering from a dietetic deficiency, but in view of Hartley's results in guinea-pigs such is a possibility.

*Interval after which active immunity develops.*—It is a common belief that it takes a week or ten days for immunity to develop after the administration of vaccines. Wright and his school have shown that changes in the opsonic power of the blood can be observed in a few hours, and that the nature and degree of the change depends largely on the dose administered. Other demonstrable antibodies, such as agglutinins or bactericidal substances, have been detected in from one to four days. There is ample evidence that the rapidity and extent of the response to an antigenic stimulus is greater when the animal has established a basal immunity, but the interesting observations of Hedley Wright show that even in the unprepared animal (without basal immunity) there is a change within five hours of the inoculation of pneumococcus vaccines which assists the animals in ridding themselves of the infection.

There is, therefore, evidence that following the administration of a vaccine some immunity develops in a few hours.

*Combination of immunization with chemotherapy.*—At present we are in a chemotherapeutic age, and all manner of ailments are being treated—rightly or wrongly—with sulphonamide drugs. The special function of these drugs is to inhibit the growth of sensitive bacteria; but the actual destruction of the bacteria has to be carried out by the body. It seems clear, therefore, that the higher the state of immunity the better will be the apparent result of the drug. Two experiments bearing on this point are cited:

I.—*In vitro:* Blood infected with pneumococci is mixed with certain things as under, and after incubation for twenty-four hours the colonies are counted.

Infected blood + saline	Colonies
" " + antipneumococcal serum	00
" " + M & B 693	00
" " + antipneumococcal serum + M & B 693	00 (small)
" " (deleucocytised) + antipneumococcal serum + M & B 693	0
	00 (small)

Neither the serum nor the chemical could eliminate the pneumococci. The combination could, but only when the leucocytes of the blood were present.

II.—*Combination of active immunity and M & B 693 on pneumococcal infection of mice:* Some mice were immunized with 1 dose of pneumococcal vaccine and others were left as

controls. After one week they were all infected with pneumococci and some were treated with M & B 693. The results obtained were as follows:

Unvaccinated (No M & B 693) all died (1 M.L.D.)	
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These observations, and many others, show that with advantage immunotherapy and chemotherapy can be combined.

**Conclusion.**—The chemists have, in recent years, made extraordinary advances in many directions and they are rapidly extending their activity to problems of immunity. In 1939 it was found that immunity to a certain type of pneumococcus could be produced by a combination of horse serum globulin and cellobiuronic acid, and very recently it has been shown that substances having the properties of antibodies can be produced *in vitro* by suitable mixtures of antigen and globulin. The day may come when we use relatively simple chemicals as antigens in the production of active immunity, and when antisera are produced in test tubes instead of in horses.

**Mr. A. T. Glenn:** Any scheme for active immunization with soluble toxins or their products should be based upon the principles of primary and secondary stimulus. The first injection into a normal animal causes a slow production of antitoxin and also prepares or trains the tissues to produce antitoxin far more rapidly in response to a subsequent injection. With adequate dosage the maximum antitoxin response occurs about ten days after the second of two injections given at an interval of four weeks. In the active immunization of man against diphtheria the maximum dosage of the present form of antigen which can be tolerated without undue reaction is not sufficient to give such rapid immunity. A knowledge of the response in animals to small doses is therefore important. If the initial dose is small, the tissues are not sufficiently trained to respond rapidly to a second injection and antitoxin production follows a course intermediate between the usual primary and secondary responses. Animal variation is also greater than when larger doses are used. In a group of guinea-pigs given two injections of a poor quality toxoid each containing 2 Lf doses with an interval of four weeks, 19% gave a secondary response, in a second group given 5 times as much antigen 55% responded rapidly; further experiments showed that 93% gave a secondary response to two injections of a good quality toxoid each containing 2 Lf doses though approximately equal in antigenic efficiency to 20 times the same dosage of the bad quality toxoid. Out of over 700 guinea-pigs given 2 doses of 2 Lf A.P.T. all responded well showing that four weeks after the first injection all were fully trained to give a secondary response.

It is suggested that a small dose of antigen may act as a primary stimulus on only a limited number of cells, if sufficient cells become trained in antitoxin response a definite secondary response will be evidenced; if too few cells are so trained the second dose of antigen may be mostly used by untrained cells as a primary stimulus. The resulting course of antitoxin production may show a slight rise after about ten days followed by a fall and then a further slow rise.

**Dr. P. Hartley:** Apart from a standard for the assay of diphtheria formol-toxoid introduced in Germany shortly before the war, stable standards for the determination of the potency of antigens have not been established, and methods for the biological assay in terms thereof have not been devised, for the determination of the potency of antigens. In consequence, research workers and manufacturers are at a disadvantage compared with those who prepare, and those who use in their research or in their practice substances like the antitoxins, the vitamins, insulin, or the sex hormones, the potency of which can be determined and expressed in a common notation of units. For example, the results of laboratory and clinical investigations on antigens obtained in different laboratories and different countries cannot be correlated and compared and it is difficult for manufacturers, in the absence of standards to work to, to produce antigens of known, or even of uniform, potency. This defect in our armamentarium is due, on the one hand, to the difficulty of preparing, for many antigens, dry stable standard preparations and, on the other, to the difficulty of devising methods of biological assay which are practicable and reasonably precise.

In an attempt to establish a standard and devise a method of assay for diphtheria antigen, the results of a co-operative experiment carried out in two laboratories in Europe and at the National Institute for Medical Research, Hampstead, were reported. This experiment had the limited objectives, first, of establishing the dose-response curve for diphtheria formol-toxoid and, second, of comparing the results obtained when the same doses of the same antigens were injected under the same conditions into large groups of the stocks of guinea-pigs maintained at the three laboratories. The results exhibited a wide

administered in the insoluble form of alum precipitated toxoid (A.P.T.). It has been estimated that alum precipitated toxoid is some 200 times as potent as the parent toxoid in solution. It is clear, therefore, that it is not necessarily an advantage to have the antigen in solution—in fact it may be a serious disadvantage.

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	Colonies
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" " + M & B 693	∞ (small)
" " + antipneumococcal serum + M & B 693	0
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These observations, and many others, show that with advantage immunotherapy and chemotherapy can be combined.

**Conclusion.**—The chemists have, in recent years, made extraordinary advances in many directions and they are rapidly extending their activity to problems of immunity. In 1939 it was found that immunity to a certain type of pneumococcus could be produced by a combination of horse serum globulin and cellobiuronic acid, and very recently it has been shown that substances having the properties of antibodies can be produced *in vitro* by suitable mixtures of antigen and globulin. The day may come when we use relatively simple chemicals as antigens in the production of active immunity, and when antisera are produced in test tubes instead of in horses.

**Mr. A. T. Glenn:** Any scheme for active immunization with soluble toxins or their products should be based upon the principles of primary and secondary stimulus. The first injection into a normal animal causes a slow production of antitoxin and also prepares or trains the tissues to produce antitoxin far more rapidly in response to a subsequent injection. With adequate dosage the maximum antitoxin response occurs about ten days after the second of two injections given at an interval of four weeks. In the active immunization of man against diphtheria the maximum dosage of the present form of antigen which can be tolerated without undue reaction is not sufficient to give such rapid immunity. A knowledge of the response in animals to small doses is therefore important. If the initial dose is small, the tissues are not sufficiently trained to respond rapidly to a second injection and antitoxin production follows a course intermediate between the usual primary and secondary responses. Animal variation is also greater than when larger doses are used. In a group of guinea-pigs given two injections of a poor quality toxoid each containing 2 Lf doses with an interval of four weeks, 19% gave a secondary response, in a second group given 5 times as much antigen 55% responded rapidly; further experiments showed that 93% gave a secondary response to two injections of a good quality toxoid each containing 2 Lf doses though approximately equal in antigenic efficiency to 20 times the same dosage of the bad quality toxoid. Out of over 700 guinea-pigs given 2 doses of 2 Lf A.P.T. all responded well showing that four weeks after the first injection all were fully trained to give a secondary response.

It is suggested that a small dose of antigen may act as a primary stimulus on only a limited number of cells, if sufficient cells become trained in antitoxin response a definite secondary response will be evidenced; if too few cells are so trained the second dose of antigen may be mostly used by untrained cells as a primary stimulus. The resulting course of antitoxin production may show a slight rise after about ten days followed by a fall and then a further slow rise.

**Dr. P. Hartley:** Apart from a standard for the assay of diphtheria formol-toxoid introduced in Germany shortly before the war, stable standards for the determination of the potency of antigens have not been established, and methods for the biological assay in terms thereof have not been devised, for the determination of the potency of antigens. In consequence, research workers and manufacturers are at a disadvantage compared with those who prepare, and those who use in their research or in their practice substances like the antitoxins, the vitamins, insulin, or the sex hormones, the potency of which can be determined and expressed in a common notation of units. For example, the results of laboratory and clinical investigations on antigens obtained in different laboratories and different countries cannot be correlated and compared and it is difficult for manufacturers, in the absence of standards to work to, to produce antigens of known, or even of uniform, potency. This defect in our armamentarium is due, on the one hand, to the difficulty of preparing, for many antigens, dry stable standard preparations and, on the other, to the difficulty of devising methods of biological assay which are practicable and reasonably precise.

In an attempt to establish a standard and devise a method of assay for diphtheria antigen, the results of a co-operative experiment carried out in two laboratories in Europe and at the National Institute for Medical Research, Hampstead, were reported. This experiment had the limited objectives, first, of establishing the dose-response curve for diphtheria formol-toxoid and, second, of comparing the results obtained when the same doses of the same antigens were injected under the same conditions into large groups of the stocks of guinea-pigs maintained at the three laboratories. The results exhibited a wide

variation; in particular, it was found that the Hampstead guinea-pigs produced far more antitoxin than did the animals maintained at the other two laboratories. This variation in response might be due to the fact that, whereas the Hampstead animals were exceptionally healthy and quite free from infectious disease, the other two herds were not. These variations in the physical well-being of the different stocks of guinea-pigs was evidently related to the different conditions under which the stocks were maintained and particularly to the diets administered. To investigate this possibility, two groups of guinea-pigs of the Hampstead stock were kept under the same conditions with the single exception that in addition to a common basal diet of bran and hay, each of the animals of one group were given 40 g. of mangolds daily while those of the other group received 40 g. of cabbage daily. After being maintained for one week on this diet, each animal was injected with the same dose of the same formol-toxoid, and twenty-eight days later all the surviving animals were tested for immunity. The results showed that, while 27% of the former group died during the experiment, and the remainder showed a mean weight increase of only 15%, and only the feeblest response to the injection of antigen was elicited, the animals which had been fed on cabbage all remained well, their mean weight increased by 52%, and a high degree of immunity was developed. In another similar co-operative experiment, carried out in three laboratories in this country in which the only real variable was the guinea-pigs used, it was found that in one case the antitoxin produced by the Hampstead guinea-pigs was the same as that produced by those in another laboratory, in the second case twice as much, and in the third case three times as much, antitoxin was produced by the Hampstead guinea-pigs. A third series of experiments carried out at Hampstead clearly showed that, other conditions being the same, guinea-pigs given a large ration of cabbage developed significantly more antitoxin than those given a small ration.

The results of these experiments provide a striking example of the fact, well known to workers engaged in biological assay, that it is not possible to determine potency in terms of an animal reaction, i.e. simply by observing the effect produced by its administration to a group of animals. Any attempt to establish a statutory control of antigens of the type of those commonly used for diphtheria prophylaxis on such a basis is clearly open to objection and criticism. As for other biological assays, a standard preparation is necessary.

As an illustration of the determination of the potency of an antigen by means of tests carried out in comparison with a standard preparation, the results of investigations now in progress at the National Institute for Medical Research, Hampstead, on the assay of diphtheria prophylactic, alum precipitated toxoid (A.P.T.) were reported. The standard which had been selected was a sample of A.P.T. which, when injected into 389 Schick-positive children, in doses smaller than those now officially recommended, had rendered 381 of these Schick-negative. Assurance had thus been obtained that the standard chosen was a highly effective antigen in man. A number of A.P.T.s had been tested in comparison with the standard, both in the laboratory in guinea-pigs and in the field, and it was hoped that from the results of these laboratory and field investigations it would be possible to establish a more efficient control for the potency of this important antigen than had hitherto been possible.

The results of three experiments, carried out on three groups of the Hampstead guinea-pigs, 50 guinea-pigs in each group, illustrated three points which, taken together, provide the main reasons for the difficulties in devising a method of assay which is practicable and at the same time reasonably accurate. One of these tests was done at a different time from the others and the other two were done at the same time, but the dietary conditions were deliberately varied. The varied conditions were such as might reasonably be expected to occur in any laboratory at different times of the year, or in different laboratories at the same time of year. In one case the geometric mean of the antitoxin produced by the 50 guinea-pigs to the same dose of the same antigen was 3.72, in the second test it was 4.18, and in the third test it was 6.13, units per c.c. respectively. Such a wide variation in the response of guinea-pigs emphasizes the need for carrying out tests for potency in strict comparison with a standard preparation. Other things being equal, the response of individual animals when kept under the same conditions to the injection of antigen is very variable; in tests reported on the Hampstead stock of guinea-pigs some animals produced eight times as much antitoxin as others. When the results of these three tests were arranged so as to show the antitoxin produced in groups of ten guinea-pigs each, the groups being selected at random, it was shown that, other things being equal, the geometric mean of the antitoxin produced in the five groups varied from 3 to 5, from 3.5 to 5, and from 5 to 8, units per c.c., respectively, in the three experiments.

The results of these experiments had also been analysed in order to arrive at an estimate of the accuracy attainable when different sized groups of animals were used for the comparative tests. When five guinea-pigs per group are used the limits of error ( $P=0.99$ ) are large, viz. 55% to 180%, when ten guinea-pigs per group are used the limits are 63% to 150% and when twenty guinea-pigs per group are used the limits are 75% to 135%.

With the Hampstead guinea-pigs it was shown that little advantage is gained by increasing the number of animals per group beyond twenty. The analyses revealed the interesting fact that while the amount of antitoxin produced in response to the same injection of the same antigen varied at different times of the year, or under different conditions of diet, the error of the assay showed little variation from test to test. Moreover, compared with somewhat similar tests carried out in Germany, the same degree of accuracy is attained in the Hampstead experiments by the use of much fewer animals. This is considered to be due to the more detailed information yielded by the Hampstead tests, whereby the antitoxin produced by each animal (and not the resistance of the animal to a single injection of diphtheria toxin, which merely indicates one level of immunity) was determined; and, also, to the fact that, since the Hampstead stock of guinea-pigs has been raised from a small number of carefully selected animals and are to a large extent inbred, the stock exhibits a relatively uniform response to antigenic stimulus.

[December 16, 1942]

## DISCUSSION ON IMMUNITY. II.—BACTERIAL VACCINES AND TOXOIDS

Dr. A. W. Downie: Before vaccines and toxoids are made generally available for human use they are usually tested on animals which, after inoculation, can be tested for antibody production or for resistance to infection. It is, of course, often difficult to reproduce in animals infections comparable to those which occur in man, and in estimating an antigenic effect by antibody titrations in animals or man we cannot always be sure that the antibodies we titrate are a measure of resistance to infection. The final assessment of the value of vaccines and toxoids in preventive medicine must depend on the results of clinical trials and experimental results in the laboratory are guides to that end.

The careful work of Glenny and his colleagues on the immunity response of animals to the injection of bacterial toxoids has elicited facts which hold true for man and which have guided prophylactic practice. Grinnell's experiments on mice demonstrated the poor antigenic quality of many of the typhoid vaccines in use prior to 1932 and led to much of the more recent work on the antigens of the typhoid bacillus. Knowledge gained by laboratory experiments has often been tardily applied to the prevention of infectious disease in man.

Large scale immunization with vaccines and toxoids in man is likely to be practised only against those infections liable to epidemic spread or where the mortality rate is sufficiently high to justify the labour and expense involved. In this country the number of such diseases is not great. In normal times, for example, the risk of typhoid is so small that general inoculation with typhoid vaccine is probably unnecessary.

In considering the results obtained by the use of vaccines and toxoids it is well to bear in mind the differences in these two types of antigen and their mode of action. In diseases like tetanus or diphtheria where the effects are mainly due to exotoxins the degree of protection induced by the injection of a suitable toxoid is likely to be substantial. In more generalized bacterial infections on the other hand immunity should be largely antibacterial; this is more indirect in action and appears to be more difficult to attain. One might therefore expect that better evidence would be available for the prophylactic value of toxoids than of vaccines.

*Vaccines and toxoids in the prevention of specific infections.*—The results obtained by the prophylactic use of vaccines and toxoids in the prevention of infectious diseases in man cannot be considered in detail, but a few of them are mentioned.

*Diphtheria*: Unequivocal evidence of the value of toxoid in the prevention of diphtheria is available from work published in America and Canada. In this country we have been rather slow in making use of a procedure which promised such excellent results and it is to be hoped that within the next few years we shall have for the whole of this country records of the value of immunization on diphtheria morbidity and mortality which will be as striking as those obtained in Canada.

*Tetanus*: The studies made on antitoxin production following injection of tetanus toxoid into man lead us to expect equally good results in the prophylaxis of this disease. Injection of tetanus toxoid is widely practised in the Army but the only record of its value that I have seen is given by Bensted in the Harben lectures two years ago (Bensted, 1940). These figures refer to the incidence of tetanus in those wounded during the fighting in France in 1940. Although 90% of the men in the Army had been inoculated with toxoid the eight cases of tetanus reported all occurred in those who had not been inoculated. A paper by J. S. K. Boyd and J. D. Maclellan gives further evidence of the value of toxoid in the prophylaxis of tetanus (*Lancet*, 1942 (ii), 745)



Prophylactic injection of *Cl. welchii* toxoid has been suggested for the prevention of gas gangrene but this measure has not been widely adopted.

When we consider bacterial vaccines in prophylaxis we find few diseases in which their value has been convincingly demonstrated.

**Typhoid:** In the prevention of typhoid fever Greenwood (1935) considers that the most satisfactory figures are those illustrating the experience of our troops in India between 1905 and 1908. In the 17th Lancers after one year in India there were only 2 cases of typhoid, neither fatal, among 258 inoculated men, while there were 66 cases and 11 deaths among 422 non-inoculated.

**Dysentery:** In this country vaccines have been and are being tried chiefly in mental hospitals where the risk of infection is great. W. M. Scott (1938) was of the opinion that mixed dysentery vaccines were valuable in such institutions.

**Cerebrospinal meningitis:** In 1939 Maclean and Bevan expressed the opinion that while vaccines might be valuable in the prophylaxis of cerebrospinal meningitis no really satisfactory trials had been recorded at that time. Since then results of extensive trials in Indo-China are available (Genevray, 1941), and in 1939 and 1940, 210,000 persons were inoculated with a polyvalent meningococcus vaccine made from freshly isolated strains. The disease was very prevalent in Indo-China that winter. In various inoculated groups of men, mostly colonial troops, outbreaks were stopped by 2 or 3 injections of the vaccine and the incidence of the disease was 10 to 36 times greater in the uninoculated than in the inoculated in the same areas.

**Pneumococcal pneumonia:** Although a very high degree of immunity can be produced in animals by injections of pneumococcus vaccines, the use of vaccines, or more recently of the capsular polysaccharides, in man has not always given satisfactory results. According to Orenstein (1931) polyvalent pneumococcal vaccines did not have much influence on the incidence of pneumonia in miners in South Africa. Felton and his colleagues (1938) have reported apparently good results from the prophylactic use on a large scale of a preparation containing type I and type II polysaccharide. The number of cases of pneumonia which developed in the observed groups was, however, not very high; their findings have not been confirmed by Siegel and Muckenfuss (1941) who used a mixture of types I, II and III polysaccharides.

**Whooping-cough:** While earlier workers differed in their opinion of the value of pertussis vaccine in the prevention of whooping-cough favourable results have recently been recorded. In the carefully controlled observation recorded by Bell (1941) the incidence of whooping-cough in vaccinated children was less than a third of that among unvaccinated controls who were strictly comparable in other respects.

**Combined active and passive immunization.**—Combined active and passive immunization has proved its value in veterinary medicine and has been used against certain virus diseases in man. Combined active and passive immunization was used in the prevention of diphtheria by Zingher in 1918. In this country Wilson and his colleagues (1941) have described the successful application of the method, combined with temporary isolation of carriers, in the control of diphtheria outbreaks in schools in rural districts.

Combined active and passive immunization was advocated by Ramon a few years ago for the prevention of tetanus in the wounded. It may also be of value and has been used in dealing with whooping-cough contacts.

**Age and immunizability.**—In 1938 nearly 50% of deaths from whooping-cough in England and Wales occurred in children under 1 year of age and almost a quarter of the total under 6 months of age. Allowing for wrong diagnosis, it appears that many children might be saved if the incidence of whooping-cough could be reduced in this early age-group.

There is a good deal of evidence to show that infants and young animals respond poorly to injection and are difficult to immunize. This has recently been discussed by Burnet (1941) and Sauer (1941) has shown that it is difficult to give complete protection against whooping-cough to infants aged 2-6 months by injections of vaccine. He noted, however, that when children vaccinated at this age developed whooping-cough the disease was mild and there were no fatalities. Keller *et alii* (1942) have recently shown that the antibody response to injections of pertussis vaccine in infants under 6 months, although less than that in older children, was quite considerable. The evidence suggests that infants under 6 months cannot be immunized as readily as older children but the response may be good enough to make further trials worth while.

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Dr. H. J. Parish: (a) *Vaccines* should be prepared from suitable strains, e.g. *Bact. typhosum* "Rawlings", rejuvenated and containing Felix's Vi antigen; *H. pertussis* in the smooth Phase I. Provided the growth is good and "smoothness" is retained a simple type of culture medium is preferable. A solid medium entails "washing off" and perhaps further washing of the suspended organisms, and it should be borne in mind that important antigenic constituents may thus be eliminated. "Whole" broth formol-cultures of *Cl. welchii*, Type B, are used in the prophylaxis of lamb dysentery. Vaccines are killed by heat (minimal) or chemicals such as formaldehyde, phenol, merthiolate or alcohol and these substances are also used as preservatives. Formaldehyde causes pain on injection whilst phenol and merthiolate do not irritate the tissues, and vaccines, e.g. pertussis, preserved with them are more antigenic than formalinized preparations. Unfortunately phenol may damage "toxins", which are not necessarily identifiable and titratable, and merthiolate is unreliable in its bactericidal action. Felix claims that 25% alcohol does not destroy the Vi antigen, but this is denied by Rainsford. The ideal preservative for vaccines is not known.

The determination of the essential antigens in vaccines is difficult as the following examples will show. The F.68 fraction (Raistrick and Topley) isolated from *Bact. typhosum* is a polysaccharide linked with nitrogenous compounds and is probably not as good as a vaccine prepared from whole bacteria. A similar fraction from *H. pertussis* awaits clinical trials and it is unwise to ignore the toxin of *H. pertussis* obtained by freezing and thawing (Evans). Although the corresponding antitoxin is apparently not demonstrable in convalescent serum it has been prepared in animals. Autolysate toxic protein of Shiga's bacillus often produces high titre antitoxin in horses, although "competing" antigens sometimes interfere with the response to the essential antigen. Living vaccines have an obvious disadvantage for man and larger doses are necessary if dead vaccines are used. The process of killing may harm a vaccine as (a) certain antigens are heat-labile and (b) many antiseptics denature protein.

(b) *Toxins*.—The toxin of the hæmolytic streptococcus (scarlet fever) is the only one used in human immunization. The extreme importance of good toxins (with minimal "competing" antigens) is shown in horse immunization. For example, diphtheria toxin may have a high Lf unitage, but cause "swellings" after injections; the horses lose condition and respond badly to the specific toxin present in broth filtrates. On the other hand their serum may have a high content of agglutinins even though only filtrates were used in immunization. The potency of tetanus toxin is influenced by the constituents of the culture medium, including the type of peptone, the salt content and the hardness of the water. Another difficulty concerns the bacteria themselves for toxin-producing strains behave erratically.

(c) *Toxoids*.—The remarks on toxins are applicable to toxoids generally.

Purified toxoid may be a poorer immunizing agent than crude toxoid and this is possibly due to the modification of certain antigens during purification. Non-specific adsorbents, e.g. tapioca (Ramon) and alum (Glenny) have been shown to enhance antibody production and Alum Precipitated Toxoids (A.P.T.) are made from high-grade toxoids, phenol being excluded at every stage of manufacture.

(d) *Combined antigens*.—Staphylococcus toxoid + vaccine may give a better clinical response than either preparation separately. When tetanus toxoid is mixed with T.A.B. vaccine (T.A.B.T.), there is a better response to the toxoid constituent, but, in some recent experiments, a slightly worse one to the T.A.B.

Finally, a few general comments are necessary about all antigens. A good antigen may give unsatisfactory protection unless attention is directed to the proper size and spacing of doses. In the preparation of tetanus and dysentery antitoxins in horses, a rest period of three months after the preliminary injections is advantageous. Re-inoculation of diphtheria prophylactic, A.P.T., is important in human immunization, and the same principle is now being extended to other antigens.

Dr. R. Lovell: It is doubtful if bacterial diseases have a single cause for the age, breed, species and state of nutrition of the host are factors as well as the dosage and relative virulence and infectivity of the bacterium. Artificial immunization therefore plays only

one part, albeit a great part, in the general prevention of disease and the difficulties vary with the diseases and the hosts which are attacked. In the field of veterinary medicine the economic aspect is of especial concern and the individual animal is subordinate to the herd or flock. This is an outstanding difference between human and veterinary medicine and whilst the safety of a particular vaccine is of prime importance in human medicine it is of less importance compared with its efficacy in veterinary practice. Greater risks can be run with animals than with man and this is exemplified in the more frequent use of living bacteria as vaccines. Suspensions of living spores of anthrax bacilli are used for the active immunization of cattle, sheep and horses and fatalities occur. During the years 1922-25 about two million doses of anthrax vaccine were issued from one laboratory in South Africa per year. Good batches of vaccine were expected to produce a temperature reaction in 90% of the animals tested and in the field severe reactions and deaths were known to occur. In 1935-37 about 50 deaths from vaccine anthrax were reported out of approximately sixteen million cattle inoculated. An improvement in the results was achieved by increasing the concentration of spores together with the reduction in the virulence of the strains used (Sterne and Robinson, 1939). A further modification was made during the years 1936-39 when several batches of anthrax vaccine were made from uncapsulated variants. This vaccine was safer and produced slighter reactions than the ordinary spore vaccine (Sterne, 1939a).

Active immunization in pigs against swine erysipelas is usually practised by inoculating suspensions of living organisms and immune serum. In some cases this is followed a fortnight later with the injection of a virulent culture. Although living swine erysipelas vaccines have been used both here and on the Continent for years it was only in May of this year that the Bureau of Animal Industry of the U.S. Department of Agriculture licensed the production and sale of this vaccine by commercial laboratories. (*J.A.V.M.A.*, 1942, 101, 166). According to Peterman (1942), of approximately 700,000 pigs so treated, 95% exposed to undetermined degrees of infection were protected. Some of the remaining 5% developed the disease although they were healthy before vaccination. It appears uncertain whether this was due to the vaccine or a breakdown in the immunity.

Risks may also be taken by the omission of a preservative from the vaccine and Bazeley (1942) has recently used a suspension of young *Streptococcus equi* killed by heat but with no preservative in the prevention of strangles in several thousand horses.

The different environmental factors associated with the aetiology of a disease have been referred to and a point of some importance is the amount and extent of exposure to infection to which animals may be subjected. Whereas transient exposure of a vaccinated animal to infection would augment any immunity enjoyed by that animal, continuous and severe exposure would break down that immunity. In the studies on experimental epidemiology made by Topley and his colleagues the lack of success in immunizing mice against mouse typhoid was attributed to two factors:

- (a) The low average level of immunity induced in the vaccinated mice, and
- (b) the severe and continuous risk of infection to which the mice were exposed.

The advantage enjoyed by the inoculated was very great, but for a limited period (Greenwood *et alii*, 1936). It is difficult to argue from mice to domestic animals and man but one would suggest that the environmental conditions of some of our flocks and herds approximates more closely to the experimental conditions in mice than do those of man. This can be amply illustrated in the case of swine erysipelas and one cannot afford, in spite of the levels of immunity attained, to relax the general measures of hygiene which are desirable in both spheres of medicine.

Another difference between human and veterinary practice concerns the variety of animal species which are immunized. The susceptibility to a disease and the extent of the immunity produced varies according to the species of animal, the breed and sometimes their environment. This is apparent in laboratory animals for guinea-pigs and rabbits can be immunized against anthrax without difficulty whereas it is the reverse with mice. (Sterne, 1939b). Hartley (1942) has shown the variations which can occur in guinea-pigs when changes in the diet are made and it is common knowledge that guinea-pigs are difficult to immunize against *Cl. chauvei* compared with sheep which are easily immunized. Goats which are stabled are less susceptible to an injection of anthrax vaccine than those living under field conditions (Sterne and Robinson, 1939).

Not only is there a variation in the susceptibility and ease of immunization of the different animals with different diseases but there is a variation in the duration of the immunity following vaccination. In many of the diseases the duration of a serviceable immunity is restricted to months. For example, in swine erysipelas the duration of immunity following vaccination appears to range from three to six months (Peterman, 1942) and active immunization of cattle against anthrax is frequently carried out annually (Sterne, 1939a). In flocks of sheep where lamb dysentery is rife, ewes receive an annual

reinforcement of vaccine. In some diseases a long period of immunity would appear to be unnecessary either because of a seasonal appearance of a disease or because animals of a particular age-group only are susceptible. A long period of artificially induced immunity would appear to be unnecessary against black quarter in cattle and braxy in sheep. In general, however, the active immunity induced against bacterial diseases of domesticated animals is usually short. Is this because of some inherent difficulty concerning the animal host or because of the nature of the vaccine? In the summer of 1942 a large number of cattle were injected with *C. pyogenes* toxoid in the hope that this might influence the incidence of summer mastitis. Cattle were given two doses of alum precipitated toxoid with an interval of four to six weeks. A few animals from each of five herds were bled at intervals and their sera tested for antitoxin. An *in vitro* hæmolytic test was used and the results expressed as units of antitoxin per c.c. of serum. As expected, there is a rise after the first inoculation followed by a greater rise after the second but the antitoxin content of the sera drops very quickly and at the ninety-second day the animals in one herd appeared to have no more antitoxin than before immunization. Conclusions must not be drawn from such slender data but the degree of immunity as determined by an *in vitro* test appeared of little value three months later. An increase in the antigenic value of the toxoid or further doses may give more satisfactory results.

As far as bacterial diseases are concerned in veterinary practice attention must be drawn to these facts:

(a) As bacterial diseases have not a single cause then immunization plays one part only in the prevention of bacterial diseases.

(b) The veterinary aspect towards disease is frequently an economic one and as the individual is subordinate to the herd then the safety of a vaccine is subordinate to its efficacy.

(c) A high degree of immunity is demanded if the risk to which our animals are exposed is a continuous and severe one.

(d) Owing to the diversity of diseases and animals, generalization is impossible but the duration of a serviceable immunity in animals, especially in cattle, appears to be short. This latter aspect warrants further investigation. Other lines of study which offer a chance of improving our present methods of immunization lie in determining the relative immunological importance of the different antigenic components of bacteria and the degree of importance of the toxin and bacterial bodies in such organisms as staphylococci, *C. ovis* and *C. pyogenes*.

Finally it must be borne in mind that immunization may have no effect on a carrier rate, for many immunized survivors of an epidemic may be infected and infective and as such are potential sources of danger to susceptible animals. A reduction in mortality is not always associated with an equivalent reduction of infection and although overt cases of disease may not occur following immunization a relaxation of artificial immunization results in a re-accumulation of susceptibles and a reappearance of disease (Greenwood *et alii*, 1936).

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Mr. S. J. Gilbert in *absentia* read by Dr. A. W. STABLEFORTH: *The immunization of goats and cattle against Brucella abortus by means of dead vaccine.*—The work described provides a proof of the possibility of conferring a high degree of resistance to *Br. abortus* infection, by means of a dead vaccine. Previous experiments have not shown that much immunity has been produced by dead vaccines, and they have been mostly discarded in favour of living vaccines. Living vaccines of a virulent type reduce the rate of abortion but in some cases actually cause abortion and the animal frequently remains infected especially in the udder. Strains of lower virulence are now being used and appear to confer a high degree of immunity and are less likely to leave the animal infected, though much yet remains to be ascertained in regard to these strains, and their effects, especially as regards the duration of immunity.

The dead vaccines which have previously been used have usually been killed by heat and occasionally by formalin. Small animals have mostly been used and there have been very few exact experiments on large animals. Large scale field experiments were carried out in England and Germany some twenty-five years ago and the results were not at all

promising. These vaccines were administered in saline but latterly French workers have claimed good results from the use of suspensions in oily vehicles such as lanoline and paraffin. Unfortunately, their experiments have either been on a small scale or have been uncontrolled field experiments on sheep and cattle, the results of which are difficult to assess accurately.

In the present series of experiments goats were used for the preliminary work and the most promising vaccine tested in cattle. The vaccines were administered in a mixture of lanoline and paraffin.

*Dosage of vaccine.*—The results of two experiments in goats are briefly as follows:

(1) Of 6 vaccinated animals 5 had normal parturitions and one aborted and was infected. Six controls infected at the same time all aborted and all proved to be infected.

(2) Five goats were vaccinated about eight months before infection and all had normal parturitions but one showed a slight uterine infection. No controls were available in this experiment but of three goats which were given the same vaccine in saline and infected at the same time, two aborted and one had a premature birth; all showed the presence of *Brucella*. The dose selected for goats in the present experiments was approximately 500,000 million organisms suspended in 5 c.c. of 25% lanoline in liquid paraffin. Cattle received on a body-weight basis, 20 times this dose, i.e. about 10 million million. This represents about 300 mg. of wet centrifuged deposit in the case of goats and about 6 g. for cattle.

*The test dose.*—The infective dose used for goats was 150 million organisms of a virulent strain (No. 544) instilled into the conjunctiva; in cattle 45 million organisms were given. This is probably more severe than exposure under field conditions.

*Methods of examination.*—An examination was made of foetal membranes, foetus and milk. Guinea-pigs were inoculated with uterine material and milk and subsequently killed and examined culturally and serologically. In normal parturitions when the membranes could not be found, vaginal swabs were examined.

The results of one experiment in cattle are briefly as follows: Of nine vaccinated animals one had, possibly, a premature birth and eight produced full-time calves. One of the calves was born dead but the calf and mother were not found to be infected. Four animals showed some infection. All of three control animals aborted and all were heavily infected.

*Agglutination titres.*—The agglutination titres of the sera of the cattle reached a maximum at seven months after vaccination when titres averaged more than  $1/20,000$  whilst four were as high as  $1/50,000$ .

*The local reactions.*—The vaccine was given subcutaneously and in goats this was followed by a local swelling which varied in size and was usually very firm. These swellings either disappeared or left small hard lumps which remained for a long period.

With the exception of two the local reactions in cattle became very large and unsightly. Most of the swellings were opened after three months and there was no evidence that this affected the immunizing value of the vaccine, or the agglutination titre of the sera. In two of the cattle no untoward reaction occurred at the site of inoculation and the small swellings quickly subsided. It was estimated that about 20% of cattle are unaffected by the vaccine as regards local reactions.

The local reactions do not appear to be at all painful and an experiment on 16 cattle is now in progress to ascertain the type of local reaction following the use of four different doses with various vehicles and administered subcutaneously and intramuscularly.

*The use of a rough strain for vaccination.*—Three goats were vaccinated with a rough variant of the smooth vaccinating strain and all had normal parturitions. One had a slight infection in the udder. Experiments on mice have also shown that vaccination with rough strains increases the resistance to subsequent infection with virulent cultures and there is an indication that it may be possible to immunize without producing agglutinins against smooth strains. This type of vaccination could be combined with segregation methods of control.

It is known that cattle which receive less than a fully infective dose frequently do not abort and continued vaccination of a herd might lead to elimination of brucellosis by reducing the infective dose whilst increasing immunity. It is further suggested from the work given that *Br. melitensis* could be eliminated from goats by extensive use of a dead vaccine.

The results obtained also suggest that in all bacterial diseases in which infection is followed by an acquired immunity, dead vaccines should be able to produce an increased resistance in the same way as the living organisms.

## Section of Radiology

President—F. M. ALLCHIN, M.B.

[November 20, 1942]

### Discussion on The Place of Miniature Radiography in the Diagnosis of Diseases of the Chest

**Surgeon Captain W. D. W. Brooks, R.N.V.R.:** In any discussion of the rôle of a recently introduced diagnostic measure it is as well, if possible, accurately to name the procedure to which we refer. The term "fluorography" is suggested as being fairly descriptive.

Fluorography has advantages as compared with radioscopy, in that it is probably more accurate, and that it provides a permanent record of the findings at the time of each examination; a record which permits the human error in interpretation to be corrected later. As compared with radiography of the chest the outstanding features of this method are its greater speed and considerably reduced cost; features which make it particularly suitable for the examination of large numbers of individuals. The reduction in size, however, is such that when, for instance, the 35 mm. film is used, some loss of detail is inevitable. It is of the utmost importance to determine, therefore, if the loss of accuracy in detail is so gross that the advantages of speed and economy are more than offset. Evidence has accumulated on this point. Long (1941), surveying the available U.S.A. (Army) material in 1941, found that diagnostically standard films were superior to the 4 × 5 in. films which were to a considerable extent beginning to be used there, and that these in turn were superior to the 35 mm. fluorographs in the detection of small lesions. Bridge (1942) reports similarly. Cole and Coon (1942) compared 35 mm. fluorographs with the standard 14 × 17 in. radiographs in 500 cases, and recorded equality in value in the diagnosis of significant adult type tuberculosis. In England, Clark, Poulsson and Gage (1941) compared and independently reported upon a thousand 35 mm. fluorographs and the corresponding routine chest radiographs, and found them to be closely comparable as far as the ability to distinguish the pathological from the normal was concerned. Fitzpatrick (unpublished communication) has also similarly compared the findings in 500 patients and reports identical interpretations by the two methods. While these records are significant they concern various disorders including relatively gross disease. I do not think they give us the information we really need, however, for we ask of fluorography especially that it shall permit the diagnosis of intrathoracic disease at an early stage. Thus, until a considerable number of cases, for example, of minimal adult type tuberculosis have their routine radiographs and 35 mm. fluorographs interpreted independently, and the results compared, we shall not get a really sound impression of the comparative accuracy of this new method as regards the identification of small but important lesions.

The realization that early adult type pulmonary tuberculosis is commonly symptomless, and the better results obtainable if it is identified and treated at an early stage led to the investigation of the apparently healthy. The extended examination of contacts proved a fruitful source of both new and early cases, and to this in turn were gradually added surveys of groups of the population. The results of typical researches using routine radiography were seen in the reports of Wingfield and MacPherson (1936) in England, and Edwards (1940) for New York City in the U.S.A. The more recent utilization of fluorography, particularly by the Services, has been widespread over the world.

In the spring of 1940 the Royal Navy instituted this method of investigation under the ægis of the then Medical Director-General, Sir P. Nicholls, following the endeavours of the present Medical Director-General, Sir Sheldon Dudley. It was from the first decided to examine the whole Service. The early results obtained were reported by Dudley at this Society in March 1941 (*Proc. R. Soc. Med.*, 34, 401), and at the same meeting Fitzpatrick described the technique of examination and working details of his department which he had devised and found to be most suitable. Since then it has been our experience that the methods he originated are, with but slight modification, satisfactory in the other naval establishments which are now at work. Late in 1940 its use was extended under the direction of Gage, Clark and others in London for Norwegian nationals. In 1941 we gladly showed members of the Royal Air Force the technique we had evolved at the first of the Naval bases to use this method. Later in that year fluorography was started by the Royal Air Force, and some of their results have been published by Trail (1942). I understand that the Army are now beginning on their own account. Finally, the Ministry of Health

promising. These vaccines were administered in saline but latterly French workers have claimed good results from the use of suspensions in oily vehicles such as lanoline and paraffin. Unfortunately, their experiments have either been on a small scale or have been uncontrolled field experiments on sheep and cattle, the results of which are difficult to assess accurately.

In the present series of experiments goats were used for the preliminary work and the most promising vaccine tested in cattle. The vaccines were administered in a mixture of lanoline and paraffin.

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together. In all, 1,370 cases with this lesion were found, i.e. 8.2 per thousand of those examined. Figures have just become available which show that during the third quarter of 1942 some 50,000 other members of the Navy were examined among which the incidence of pulmonary tuberculosis was very slightly higher.

In order that comparison with radiological and fluorographic surveys in the U.S.A. might be facilitated these cases were classified radiologically into three groups whose limiting criteria have recently been quoted by Crawford (1942). It is seen that approximately 36% had minimal, 43% moderately advanced, and 21% far advanced adult type pulmonary tuberculosis. A more detailed analysis of our figures shows that the relative incidence of far advanced disease increases, and that of minimal disease decreases with age and duration of service. Long's corresponding figures for the U.S.A. Army were 50%, 43% and 7% respectively, but it must be remembered that they refer almost exclusively to young recruits.

Sixty-nine additional cases with various other tuberculous lesions were also discovered, making a total for tuberculosis in all its forms of 1,439 cases, or 8.6 per thousand examined.

A very considerable number of non-tuberculous intrathoracic disorders were found, in aggregate 474 cases, or 2.8 per thousand examined. The incidence of the individual lesions is of some interest. For example, 22 cases of congenital dextrocardia were encountered, a number which is approximately equivalent to one in each 8,000 of these British males. One bronchial adenoma was encountered and was successfully treated. There were two cases of carcinoma of the bronchus, both of which proved to be inoperable. Not a single example of this disease was disclosed during the third quarter of 1942. Thus, of some 217,000 males surveyed fluorographically two only were proved to have this disease, and these were in an advanced stage. Although of this total only some 28,000 were over the age of 35, and though slightly less than 3,000 were more than 50 years old, none the less the incidence is so small that it would seem probable that among the apparently healthy fluorography will prove to be of little assistance in the early diagnosis of this most important disorder. On the other hand, bony tumours, parasitic and other cysts, and mediastinal neoplasms of all kinds are demonstrated at an early stage by fluorography with an incidence which would be anticipated from their known frequency of occurrence, and the advantages to the patient of the early application of proper therapy including, of course, thoracic surgery, have already been apparent. The frequency of these various disorders, and the significance of the swift application of proper therapy, make it desirable that a fluorographic survey should not be exclusively, or even for the most part, in the hands of those whose entire concern is the management of cases of pulmonary tuberculosis. Instances of the more chronic forms of pneumonia constituted forty-nine cases and are an important group, for it was anticipated that cases of this type might cause considerable difficulty in diagnosis, especially in relation to pulmonary tuberculosis. This has not proved to be the case, for in the vast majority the distinction was quite simple in hospital. Cardiac disease and bronchiectasis probably figure less often than most of us would expect. However, as regards pathological as distinct from anatomical disorders, the incidence disclosed by this survey is modified both because the method of selection is fluorographical, and because the subjects were apparently fit members of the Royal Navy, in which routine medical examination was always available, and had, in fact, in a high proportion recently been undertaken. In the instances of cardiac disease and bronchiectasis it is well known that a considerable proportion of cases are not disclosed at simple radiological examination; they are similarly not disclosed at fluorography; moreover, most cases of these two disorders which do give radiological evidence of their existence also have significant symptoms and signs which would bring them to the notice of a medical officer, and so exclude them from this investigation. Thus, to figure in this survey not only must the lesion be identifiable at fluorography, but also it must be such that it presents very slight clinical evidence. On the other hand, the application of fluorography to the general population who are not examined medically as a routine, and who often have other reasons for concealing their disabilities may be anticipated to give a rather different incidence in the pathological disorders disclosed.

TABLE II.—DISTRIBUTION OF THOSE EXAMINED AND FOUND TO HAVE RADIOLOGICAL EVIDENCE OF ADULT TYPE PULMONARY TUBERCULOSIS—MALES (R.N.).

Age (years)	No. examd.	No. with Pul. T.	No. with Pul. T. per 1,000 exam.	Age (years)	No. examd.	No. with Pul. T.	No. with Pul. T. per 1,000 exam.
10—14	22	—	—	50—54	1,423	30	2.1
15—19	42,365	184	4.3	55—59	482	12	2.4
20—24	57,281	323	5.6	60—64	71	—	—
25—29	27,117	256	9.4	65—69	6	—	—
30—34	18,274	200	10.9	70—74	2	—	—
35—39	10,524	173	16.4				
40—44	6,163	132	21.4				
45—49	2,868	60	20.9				
				Total	166,598	1,370	8.2



intend to utilize it for the civil population as soon as sufficient apparatus and personnel are available.

An important disadvantage of the procedure is the production of anxiety neurosis in a small proportion of those examined. These cases tend to occur especially among those who are already predisposed to this disorder, and who require protracted investigation. Improvement often results if, during hospital investigation, the whole position is carefully explained to the patient, and probably as the public becomes better educated in regard to pulmonary tuberculosis, and to this type of examination the frequency may decrease. It should also be made plain to the patient that the procedure itself offers no direct protection from tuberculosis or any other chest disease.

The increasing employment of this method of investigation makes an assessment of its usefulness as a diagnostic measure in diseases of the chest desirable. For this purpose the results obtained by the examination of more than 200,000 members of the Royal Navy seem of value. It is essential to explain that every member of the Royal Navy recurrently passes through certain depots at which facilities for this investigation have been provided, so that the first examination, and also subsequent re-examinations at appropriate intervals of time, are possible not only for the new entry, but for the entire Service. Routine clinical examination is in no way modified. Partly in view of the uncertain limits of accuracy of the method we have, from the beginning, used it essentially as a kind of sieve. Thus, every individual who has any thoracic abnormality whatever revealed by fluorography is submitted to routine radiological examination at which a radiological diagnosis is made. It is within the authority of the radiologist in charge of the department to return to duty without further ado those who at fluorographic examination are normal, and also those whose abnormality at the radiological examination is restricted to anatomical variants such as congenital dextrocardia, or to such lesions as calcified primary tuberculous complexes. All those with clinically significant disorders are sent to hospital where they are fully investigated, and the success of the whole survey largely depends upon the efficiency and accuracy displayed in this phase. Only upon a synthesis of all the findings is a decision as to disposal finally made. Our whole experience of fluorography has confirmed again and again the wisdom of this restriction in its use in diagnosis. The work is carried out at each depot and hospital by a closely linked team of radiologists, clinicians and ancillary staff, and the whole survey is further co-ordinated since the services of a consultant are available. At every stage, including the hospital investigations, a standardized routine has been devised which makes for efficiency and which facilitates both the exact registration of cases, and also the statistical compilation of the results ascertained.

TABLE I.—RADIOLOGICAL CLASSIFICATION OF THE LESIONS DISCLOSED BY PHOTORADIOGRAPHIC SURVEY OF 166,598 BRITISH MALES (R.N.).

Lesion	Cases per 1,000 examd.	No. of cases	Lesion	Cases per 1,000 examd.	No. of cases
<b>Pulmonary Tuberculosis</b>			<b>Mediastinum—</b>		
(adult type) ...	8.2	1,370	Neurofibroma ...		2
Minimal ...		498 (36.4%)	Dermoid ...		4
Moderately advanced ...		584 (42.6%)	Substernal thyroid adenoma		5
Far advanced ...		288 (21.0%)	Lymphadenopathy ? cause		15
<b>Other tuberculous lesions</b>	0.4	69	<b>Cardiovascular—</b>		
Active primary tuberculosis (pulmonary) ...		27	Dextrocardia (congenital)		22
Miliary tuberculosis (chronic) ...		3	Cardiac disease ...		20
Pleurisy with effusion ...		35	Aneurysm of aorta ...		1
Tuberculous empyema ...		3	<b>Parasitic cysts—</b>		
Spinal caries ...		1	Hydatid cyst of lung ...		3
			Hydatid cyst of liver ...		2
<b>Non-tuberculous lesions</b>	2.8	474	<b>Bronchi and Lung—</b>		
<b>Pleura—</b>			Chronic bronchitis and emphysema		50
Chronic pleurisy ...		158	Bronchiectasis (all types)		25
Spontaneous pneumothorax		2	Bronchial carcinoma ...		2
Chronic empyema ...		7	Bronchial adenoma ...		1
			Chronic pneumonia ...		49
<b>Diaphragm—</b>			Pulmonary fibrosis ? cause		9
Phrenic paralysis ...		8	Silicosis ...		1
Eventration ...		2	Anthraxis ...		20
Hernia ...			Undiagnosed ...		
			<b>Bones—</b>		
			Chondroma of rib ...		3
			Cervical rib ...		25
			Hemivertebra ...		1
			Scoliosis ? cause... ..		3
			<b>Total</b>	11.4	1,913

In Table I is presented a classification of the abnormalities which were detected at the examination (to July 1942) of 166,598 British males. It will be seen that numerically adult type pulmonary tuberculosis is outstandingly the most important disorder disclosed. Indeed, it is nearly three times as numerous as an abnormality as all the remainder put

these figures. Bearing in mind that the incidence of symptomless pulmonary tuberculosis increases with age, and that for each age-group the proportion with active disease is approximately 40% of those showing this lesion, and finally, that the incidence of far-advanced pulmonary tuberculosis is greater among the older examinees, it would seem probable that a greater proportion of the more significant "carriers" of this disease are to be found among the middle-aged and elderly. That this is true for the civilian population as well as for the Navy is likely, since at radiological survey both in the coloured and white populations of New York City similar findings were recorded by Edwards. It might be argued that such patients are of less importance than the young as "carriers" of the disease, because in the natural course of events they might be anticipated to die sooner. Such a conclusion is not, however, supported by available evidence. Manifestly, they show to a greater degree than the young the combination of extensive disease and the ability to lead an active life in apparent health. Furthermore, clinical experience shows that the mortality rates for those having this disease are consistently higher for both sexes in adolescence, for instance, than in the fourth and fifth decades. Lastly, the finding that the stability of apparently inactive lesions is greater among the older patients also has a possible indirect bearing upon this same concept. These patients are the tough survivors of all the army of the tuberculous, and like old soldiers they are dangerous and die hard. If, therefore, it is our aim to attempt to achieve control of this disease at the earliest possible opportunity it would seem wise to employ the diagnostic potentialities of fluorography with due regard to that section of the population in which the largest proportion of significant cases of tuberculosis are likely to be found. If this concept of the value of fluorography is accepted, its particular application to adults and older members of the population would seem likely to be productive both of a greater case yield per unit of cost, and with adequate segregation and treatment would give rise to a more important reduction in the size of the source from which the population repeatedly becomes infected by the organism responsible for this disease. Re-examination is another matter; for, the susceptibility of the young in acquiring tuberculosis, and their greater liability to relapse after having apparently arrested its progress, are indications of the special necessity for continued observation, and this can very efficiently be performed by fluorography. Such a procedure will furthermore lead to the identification of a greater proportion of relatively early lesions for which therapy is most likely to achieve success.

[Article abridged; acknowledgments and bibliography omitted in view of paper shortage.]

**Major J. Duncan White :** Major Kerley has carried out a survey of some five thousand Army personnel and the figures he reports of unsuspected intrathoracic disease are very akin to those given by observers in the other Services.

In Norway, under the present German domination, by a law dated April 1942, it is incumbent upon every person over the age of 15 years to submit to chest fluorography at intervals of two years; the charge for this is one krone, and the fact that the individual has complied with the law is stamped on his identity card. A wise proviso, in my opinion, is that only the State may organize these mass surveys. In the American Army men are examined prior to being enlisted, the examinations are carried out by military personnel, in most centres 4x5 in. stereoscopic films are used, and about 5% of those thus examined have full-size "check-up" radiographs. The value of this sieve (from the Army's point of view) is shown by the following figures: the annual ratio per 1,000 of admissions to hospital for pulmonary tuberculosis prior to the World War of 1914-18 was 5, during that war it rose to 12, but since then there has been a gradual decline from 4 in 1920 to 1.4 in 1940 and it is estimated that for 1941 the figure will be of the order of 0.5. So far there does not appear to be any appreciable increases in the incidence of tuberculosis in the United States; on the other hand it is stated that about 1% of the male population of military age have active tuberculosis and the examining medical boards are rejecting some 1.4% of men examined on the grounds that the miniature films show evidence of a pathological condition. A recent German broadcast gave the information that 1,300 tuberculosis advice centres are now in operation in that country, that nearly 2 million fluorographs have been made, and that 30,000 previously unsuspected cases of tuberculosis were thus discovered, that is 1.5% of those examined. I think that perusal of the Medical Research Council's interim report on tuberculosis in war-time will force the sceptic to agree that mass chest surveys are a vital step in the direction of the earlier detection of this disease.

It has been stated that, by fluorography, we may miss minimal lesions since we are merely recording photographically the screen-image. I conceive that this may be possible but it does not follow that we must condemn the method for this reason. It is agreed that the correct procedure is that any individual, whose fluorograph is suspicious, shall be examined further by full-size radiograph. If he then is still suspicious radiologically he must be submitted to full clinical and bacteriological examination.

A similar increase with age occurs in the female subjects also examined, and though their total number is not yet sufficiently large to be very significant statistically it is of interest that for every age-group, as for the whole total, the proportions with adult type pulmonary tuberculosis are slightly less than the corresponding figures for males.

The results of the hospital investigation showed that of 8.2 per thousand who were found to have this disorder, 3.3 gave evidence of active disease, and of these 2.2 were producing identifiable tubercle bacilli, i.e. more than 25% of the total with radiological evidence of the disease. The absolute and relative numbers of those with active and inactive tuberculosis increase steadily with age, but further analysis shows that the proportion of active to inactive cases is astonishingly constant at all ages—active disease accounting for some 40% of the total cases.

Among those who at first examination had apparently inactive pulmonary tuberculosis, a considerable proportion were discharged to what is called Category "C". In general these were cases in which we felt some uncertainty as to the inactivity of the lesions. In practice this type of case presents by far the most difficult problem for the physician. Prolonged hospitalization, followed by further observation, seemed the only sound available method, and consequently such patients were, after discharge from hospital, given light duty on shore and were re-examined after an interval of time suited to the case, often one of three months. The subsequent fate of this group is of considerable interest, because when this method is applied to the civilian population I am quite confident that it will be here, for a variety of reasons, that the greatest clinical and administrative difficulties will be met. In Table III is presented the result of the re-examination of the first 189 such patients who

TABLE III.—CASES RE-EXAMINED AFTER THREE MONTHS OR MORE SHORE SERVICE (CATEGORY C), ORIGINALLY FOUND TO HAVE RADIOLOGICAL EVIDENCE OF ADULT TYPE PULMONARY TUBERCULOSIS WHICH AT FIRST CLINICAL EXAMINATION GAVE NO EVIDENCE OF ACTIVITY.

Disposal after re-examination, 189 cases.

Shore service and re-examination, 66. Invalided, 59. Full duty, 64.

Age	Shore service and re-examination	Invalided	Full duty	Totals
15-19.9	11 (31.4%)	18 (51.4%)	6 (17.1%)	35
20-24.9	15 (35.7%)	15 (35.7%)	12 (28.6%)	42
25-29.9	11 (35.5%)	8 (25.8%)	12 (38.7%)	31
30-34.9	17 (38.6%)	11 (25.0%)	16 (36.4%)	44
35-39.9	5 (25.0%)	4 (20.0%)	11 (55.0%)	20
40-44.9	5 (41.7%)	2 (16.7%)	5 (41.7%)	12
45-49.9	2 (40.0%)	1 (20.0%)	2 (40.0%)	5
Totals	66 (34.9%)	59 (31.2%)	64 (33.9%)	189

N.B.—Percentages given are those of the corresponding total in the right hand column.

had had at least three months' light duty on shore, after a first examination at which, to every available test, evidence of active disease could not be found. It will be seen that roughly one-third of the total were invalided because they had developed evidence that their lesions were, in fact, active and progressive. One-third, we felt satisfied, were examples of inactive pulmonary tuberculosis and might safely be discharged to full duty, and in one-third we were still uncertain, and so returned them to further shore service in the same category. It will be seen that of those who broke down during this interval of time, the proportion was highest in the younger age-groups. In other words, the older a patient was who at first examination gave evidence of apparently inactive pulmonary tuberculosis the more likely it was that his disorder would remain inactive. It may well be that, as the numbers re-examined in this category accumulate, the observed proportions will alter slightly, but I believe that the figures presented are a fair sample of what may be anticipated in this, the most difficult and perhaps the most important type of assessment confronting us.

The incidence of calcified primary infections climbs fairly steadily from approximately 9 per thousand at the age of 17, to 20 per thousand at the age of 42.5, then remaining fairly constant. Very strict criteria of diagnosis of calcified primary foci were used, and fluorography may fail to show many revealed radiologically, and this may account for the relatively small incidence of the lesions disclosed. It is of academic interest that though the incidence is lower the shape of the curve roughly corresponds with that of the incidence of infection as determined by tuberculin reactions for males in these age-groups. The fact that an increase in the age-incidence of calcified primary foci was found should be correlated with the fact that, as shown in Table I, an appreciable number (27), ultimately diagnosed as examples of active primary tuberculosis, were found in a survey of males of more than 15 years of age.

Further deductions of importance which are relevant to our subject may be made from

## Section of Ophthalmology

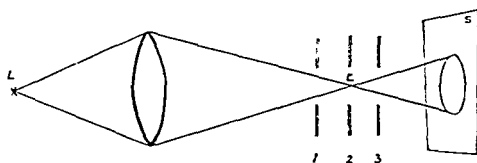
President—FRANK A. JULER, F.R.C.S.

[November 13, 1942]

### Retinoscopy [*Abridged*]

By M. KLEIN, M.D.

The principle underlying clinical measurement of the "refraction" of the eye is to determine the position of the image in space of a light-source which in this case is the retina. The determination of the image is in practice very difficult, and in retinoscopy the *aperture-test* is used by means of which it is possible to determine the "crossing-point", i.e. the image plane of a light-pencil. If the screen S is at a certain distance from the image-plane L', a light-patch is formed on the screen. Now, if an aperture is placed in the way of the light-pencil, and the light-source is moved, a "with" shadow will appear when the aperture is at position 1 (see fig.); an "against" shadow will appear at position 3, and a sudden change of light and dark without any noticeable shadow movement at all, at position 2. This is the neutral point, and it corresponds to the image plane. This aperture test is the basis of retinoscopy.



Of the two systems the *first* creates and moves a light-patch on the patient's retina. In this system the elements are: *source*, which is the image of the retinoscopic lamp formed by the mirror; *apertures*, the edge of the mirror, and the pupil of the patient's eye; and *screen*, on which the light-patch is formed, i.e. the retina of the patient. The task of the first system is fulfilled when this light-patch has been projected on to the patient's retina. From now on this light-patch acts as a light-source which emits light in the opposite direction to the first system. The elements of the *second system* are: *source*, patient's retina; *apertures*, patient's pupil and examiner's pupil (or hole of retinoscopic mirror), further, the *refractive media* of the patient's eye which determine the vergence of the emitted light-pencil, and lastly, the *screen* which is the examiner's retina. The vergence of the emitted light-pencil is determined by means of the neutral point, and the refractive error is measured by means of spectacle lenses. In myopia of more than 1 D, the shadow movement corresponds with the position of the aperture at 3 ("against" with plane mirror). In myopia of less than 1 D, emmetropia and hypermetropia, the shadow movement corresponds with aperture position 1 ("with" shadow), and myopia of 1 D which is the neutral point, to position 2.

*Factors.*—(1) In this presentation the *retinoscopic field* can be dispensed with, and the mirror-hole itself substituted for it.

(2) *Speed of shadow-movement:* The emitted light-pencil is divergent in hypermetropia, convergent in myopia, but beyond the crossing-point this becomes divergent again. With the increase of the refractive error the con- or di-vergency of the light-pencil increases. The examiner is sitting in the light-pencil itself, and the area of the cross-section of the light-pencil at the plane of the retinoscopic mirror will decide the apparent speed of the shadow-movement. If this cross-section is large it takes some time—and some movement of the mirror—till all the rays pass the mirror-hole, and it will be perceived as slow. When spectacle lenses are put before the eye, and the refractive error is being corrected, the area of the light-pencil becomes smaller and smaller, and very little movement of the mirror will be sufficient to pass the light-pencil over the mirror-hole (increase of speed).

There is an interesting paper (Crawford, J. W. (1942) *Lancet* (ii), 89) on pulmonary tuberculosis in men discharged from the Army because of this disease; in 300 cases of parenchymal lesions 66% were described as moderately advanced, 10% as advanced, and only 24% as minimal, yet all these men had been passed comparatively recently by the recruiting medical boards. His illustrations bear out the contention that at least three-quarters of the total number would have been rejected for service had fluorography been available soon after enlistment.

Fluorography demands films of the highest technical quality and interpretation must be done by a really skilled observer. It is my opinion that each fluorographic unit should have its own team of trained workers and that this team should operate the unit under all circumstances. This is the only way in which a consistently high standard of miniature film can be ensured and, naturally the medical officer responsible for the interpretation would be really experienced because of the vast numbers of film strips he would interpret. It has been found already that the more experienced the medical officer the smaller is the number of fluorographs classified as "suspicious" and the smaller the number of "check-up" full-size radiographs in consequence.

Of any large group of individuals examined by fluorography it is probable that some 3-5% will require full-size radiography; in my opinion such "check-up" examination should be done with the apparatus employed for fluorography, and provision for this has been made in the units now being built for the Army and for the Ministry of Health. These mass surveys must be conducted with the minimum of interruption of the ordinary activities of the examinees, otherwise antagonism to the scheme may arise in the minds of the education authorities, or works managers. Further, since there is no legal obligation for any individual to be examined, in order to obtain his co-operation it will be necessary to reduce any inconvenience to a minimum.

Surgeon Captain Brooks has very kindly sent me details of the cost of running static units in the Royal Navy. The annual cost per unit is found to be £2,265, the bulk of which sum is required for the payment of the team's salaries, the remainder including wear and tear, depreciation, servicing of the apparatus, and material used. Initial cost of apparatus and costs in relation to buildings utilized for the work are excluded from this estimate. The cost for each person examined is shown to be just under eightpence, and that for each abnormal case discovered £2 16s. On first sight these figures appear to be high, but surely any method of examination which helps to promote the earlier diagnosis of a lethal and infectious disease is to be encouraged.

**Wing Commander R. R. Trail (Summary):** The main lessons of experience to date are as follows:

(i) Economy of staff must be placed against necessity of making fullest possible use of each unit. (ii) Constant overhaul of apparatus working within some 60% of its full capacity must be maintained. (iii) 1,500 to 1,800 examinations a week form a good average for consistent high standards. This means a static unit could do 75,000 to 100,000 examinations a year. 35-40 per 1,000 will require large films, about 20 per 1,000 clinical examination, 8 of these showing parenchymatous tuberculosis and about 3 per 1,000 requiring sanatorium beds.

How far do these broad lessons give indications on the future employment of mass radiography on a national scale? The answer depends on inclusion of such points as: (i) Growing experience. (ii) Review of past mass-surveys, as in United States. (iii) Number of machines available, with staffs. (iv) Response of the public. (v) The place of the general practitioner. (vi) The provision of extra beds and staffs, nursing and domestic.

The weekly and annual capacity of a unit is a prime consideration for the enthusiast and the obstructionist; the former will see then the enormity of the programme; the latter that he has time to foresee his difficulties. It will take at least eighteen months to two years to establish the first 25 Ministry of Health units, which must be scattered. Each will do on an average some 30,000 examinations a year and require some 40 sanatorium beds.

A long-term policy for the annual review of adolescents up to early adult life would seem the soundest at the moment.

A central control with sensible decentralization is desirable.

Mass radiography gives a corner-stone for the previously uncorrelated aspects of the control of tuberculosis. Control of machines and guidance on interpretation would open the way to a higher standard. The individual unit should work as a clinical unit on the lines of an efficient out-patient department of a chest hospital, contacting in the same way the general practitioner and specialist services, the tuberculosis officer or the cardiologist. The central body could collect data and give statistics of real value to public health and preventive medicine, and distribute to every unit the advances made by any individual unit.

Transillumination threw an opaque shadow in the upper part of the globe. The peripheral visual field was full, but there was a scotoma corresponding to the affected area of the retina. There was a shallow detachment of the lower part of the retina.

*General medical examination.*—No evidence of metastases found. X-ray of skull and chest normal. Ear, nose and throat examination negative. *Diagnosis.*—Choroidal sarcoma in right eye.

*Discussion.*—The PRESIDENT said that he thought S/Ldr. Cashell's case was one of malignant melanoma and should be excised.

S/Ldr. CASHELL said that a similar case was shown by Air Commodore Livingston; this was taken to be innocent, but later the growth increased and the eye had to be excised. It was found to contain a neoplasm.

Mr. G. W. BLACK said that he would like explored the relationship between the swelling and the history of injury. He had lately seen a case in a man aged 22 who had attended a neighbouring hospital following a blow on his eye from a large missile. He was treated for a time and then one day it was discovered that the vision was very dim. When he first saw the patient he had a large sarcoma.

## Chiasmal Arachnoiditis

By A. J. B. GOLDSMITH, F.R.C.S.

THE inclusion of arachnoiditis among diseases giving rise to the chiasmal syndrome is comparatively recent, and is due to the rapid advances made by neuro-surgery during and since the last war. Quincke in 1893 described the condition of generalized serous meningitis, or idiopathic internal hydrocephalus, the symptoms of which resemble those of tumour or meningitis but differ from these diseases in that repeated lumbar punctures afford good prospects of alleviation or even cure. Since then there has developed the conception of external hydrocephalus due to diffuse or localized chronic leptomeningitis. The later or localized serous meningitis may occur on the surface of the brain or in and around the basal cisternæ.

Horrax in 1924 from Cushing's clinic described 33 cases of arachnoiditis of the posterior fossa simulating cerebellar tumour, but it was not until 1929 that Cushing and Eisenhardt included arachnoiditis in the differential diagnosis of chiasmal lesions. In the same year, at the Amsterdam Congress, Gordon Holmes reported two cases of chronic localized basal cystic arachnoiditis comparable to chronic localized spinal meningitis and due to trauma or inflammation. These two cases had been operated on by Sargent on account of progressive failure of vision, and both had shown marked functional improvement. Further cases were described by Cushing in 1930 and by Craig and Lillie in 1931. The subject was fully reviewed in a study by Bollach, David and Puesch published by the French Ophthalmic Society in 1937, from which most of my knowledge has been derived. In that paper 63 cases were collected from the literature and a further 66 were added which had been operated on by Clovis Vincent and his assistants at the Hôpital de la Pitié.

The disease appears to be either rare or to have attracted little attention in this country. Hinds-Howell in his Presidential Address to the Section of Neurology in 1936 said that these cases must be sought for and that search was worth while, for, on the whole, operation results were strikingly good. Williamson-Noble in the Doyne Memorial Lecture in 1939 discussed the condition among chiasmal lesions.

In the past year while working in Mr. McKissock's neuro-surgical unit I have seen three cases, all of which have been operated on. The series is small compared with the numbers collected by the French workers, but I have thought it worth recording them. One which followed an air raid injury is of some topical interest, and the results of surgical treatment have been at least encouraging. It may be argued that the diagnosis and treatment of these cases lies more in the sphere of the neurologist, the rhinologist or the neuro-surgeon, but even if we cannot afford, like Bacon, to take all knowledge to be our province, the subject is of some importance to us in that the first complaint, that of failing vision, will bring the patient to the ophthalmologist. Further, the findings of perimetry and campimetry and the fundus appearances, though, as we shall see, by no means pathognomonic, may suggest the diagnosis.

I shall describe the three cases which we have dealt with first, and then discuss briefly the main features of the disease and the views which are held as to its ætiology.

The first patient was a woman, M. H., admitted to hospital in April 1942. She was aged 32, married, no children, occupation—house-work, formerly a worker in an aircraft factory. There was nothing in her family history nor in her personal history except for a motor-cycle accident fourteen years ago following which she was unconscious for twelve hours, but suffered no sequelæ. In 1939 she began to have attacks of

(3) *Brightness of the pupillary light*: The factors are (a) brightness of the source; (b) distances; (c) apertures; and (d) losses in transmission.

(a) If the brightness of the source is increased the illumination of the retinal light-patch will increase. In two given bulbs of equal candle-power the one which has an incandescent element of a smaller surface will have greater intrinsic brightness. The intrinsic brightness (candle power per square in.), e.g. of a tungsten filament in vacuum is 960, while the tungsten arc in the "Pointolite" lamp has 12,000-16,000.

(b) Distances: The illumination decreases with the square of the distance. With plane mirrors the rule is simple, the nearer the source is to the mirror, the better will be the light output. In concave mirrors, however, their focal length too has to be considered.

(c) Apertures: Edge of the mirror, patient's pupil, mirror-hole (or examiner's pupil). If all other remain unchanged a comparison can be made between plane and concave mirrors. In plane mirrors the utilized portion of the light-pencil, i.e. the part of the light-pencil which enters the pupil is not influenced by the mirror, and it is determined by the distance of the source from the mirror and by the size of the patient's pupil. In a concave mirror, however, the collecting angle will increase with its diameter, and more light will be reflected. The utilized portion of the light-pencil will be greater if the focal length of the mirror is such that the image of the source is formed relatively near the patient's pupil, either before or behind it.

(d) Losses in transmission are caused by imperfect reflection and by absorption of light. If only the second system is considered with the retinal light-patch as source, there are two different elements which vary continually during retinoscopy: (1) the brightness of the source, and (2) the vergence of the emitted light-pencil. The poor pupillary light in high refractive errors may be attributed to the combined effect of these two elements. In retinoscopy they show a certain parallelism, and with the correction of the refractive error both are improved, but their optima never meet.

(4) *Neutral point*: (a) Why is it that there is a sudden change of shadow and light at the neutral point? Outside the neutral point the image-elements become confusion circles, and their size increases with the distance from the neutral point. If the aperture is placed outside the neutral point, it is possible that part of a confusion circle falls in the aperture, while the rest of it falls outside the aperture, on its opaque rim. Now, if by moving the light-source the light-pencil moves across the aperture (mirror-hole) the light-patch on the screen (retina) will appear *gradually*. At the neutral point, however, there are no confusion circles, and the area of an image-element is so small that when it passes the aperture at all, it passes entirely. This means that the light-patch on the retina appears or disappears *suddenly*.

(b) What happens in the examiner's eye during retinoscopy? If the refractive error of the patient's eye is high, the examiner can see fundus details. As the refractive error is being corrected in the course of retinoscopy, the fundus details become more and more blurred, because the examiner's eye is unable to bring the emitted light-pencil to an image. At the neutral point the image of the patient's retina falls in the mirror-hole, and, being so near to the eye of the examiner, there is no possibility of "seeing" it. Only confusion circles reach the examiner's retina, and their size occupies the whole area of the light-pencil.

(c) Factors influencing the neutral point: The image formation in the eye is complicated. Even in case of sharp focusing there is a high degree of aberration. This, and the decentration of the cornea, and the unevenness of the retinal surface cause the conjugate focus of the retina to be formed not in a plane, but rather in depth. Therefore it is better to speak of a neutral "zone" and not of a "point".

#### Intraocular Neoplasm.—S/Ldr. G. WILLOUGHBY CASHELL.

*History*.—A corporal, aged 37. In 1940 was struck in right eye with an empty cartridge case. Apart from momentary blurring of vision he had no trouble with the eye and since then has been serving overseas. After returning to this country the eye still remained satisfactory until September 1942 when he noticed a slight haziness in the right vision. At the same time he noticed flashes of light in the R.E. especially at night-time. No other trouble with his eye.

*On examination*.—The left eye was healthy with a normally acting pupil and a vision of 6/6. The media and fundus were clear. The right eye had a vision of 6/24. The pupil was active. He had never worn glasses. The ocular movements were full. Examination of the right fundus revealed above the disc and macula a circular cyst-like detachment of the retina. No hole could be seen, the lower part of the cyst appeared transparent but along the upper border there was a greyish-white reflex with some proliferation of pigment.



FIGS. 1 and 2.—Arachnoid adhesions involving the dorsum sellae, optic and olfactory nerves, chiasm and brain.



FIG. 3.—Arachnoid adhesions with small calcareous plaques.

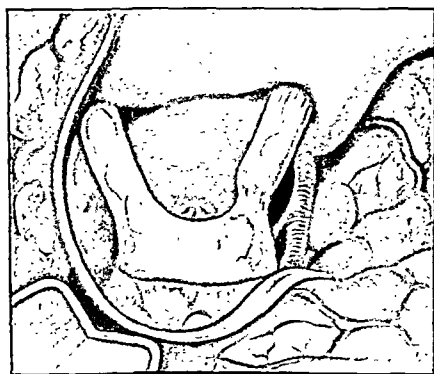
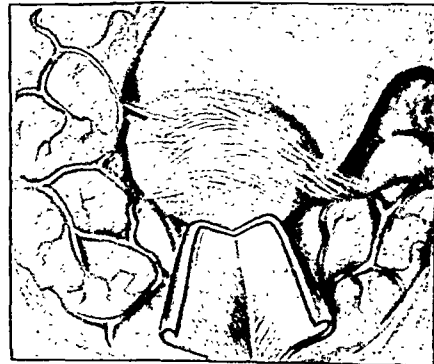


FIG. 4.—Chiasmal region after division of adhesions showing increased vascularity and also compression of the right optic nerve.



FIGS. 5 and 6.—Types with cyst formation. 5 showing multiple small cysts; 6 a large unilocular cyst concealing the nerves and chiasm.

With acknowledgment to "Les Arachnoidites Opto-chiasmiques", by Bollach, David and Puesch, Paris, 1937.

A. J. B. GOLDSMITH : *Chiasmal Arachnoiditis*

FEB.—OPHTH. 2



violent frontal and temporal headaches, worse with coughing and sneezing, and associated with vomiting and giddiness. These attacks lasted for two to three days and recurred at intervals of about ten days. Her menses ceased at about the same time and had not returned. On admission she was still having attacks of headache, but they were less severe. In September 1941 when starting work in an aircraft factory she found that her right vision was seriously defective, and had since noticed a progressive deterioration in her left eye also. Other symptoms elicited by questioning were that for several months she had noticed increased appetite and thirst, polyuria and lack of energy.

On examination she was a rather obese woman showing a normal hair distribution. The ocular findings were: A slight divergent right squint with no limitation of movement; pupils equal and reacting normally; the optic discs showed well-marked temporal pallor, especially in the right eye, the disc margins being clear cut and the vessels of normal size. The visual acuity was R. H.M.s; L. 6/36. The right visual field showed a large complete central scotoma to a 20/330 white object. The left field was full to 5 and 1 mm. object on the perimeter, but on the screen there was a temporal hemianopia to a 1/2,000 white object; temporal contraction to a 2/2,000 object as well as a concentric contraction of the nasal field to both these objects. For the rest, there was no abnormality of any part of the C.N.S. nor of her condition generally. X-rays showed a normal sella turcica. Clinical and radiological examination of the nasal sinuses was negative. The C.S.F. showed a normal pressure, chemistry and cell content, and the W.R. of blood and C.S.F. was negative.

The ocular findings suggested a pituitary lesion, particularly taken in conjunction with the symptoms of polyuria, polydipsia, polyphagia and obesity. However, ventriculograms taken after replacement of ventricular fluid by air revealed no evidence of a space-occupying lesion in the neighbourhood of the floor of the third ventricle.

We therefore considered the possibility of arachnoiditis as a cause of the symptoms, and in view of the progressive loss of vision it was felt that an exploratory operation was justified. Mr. McKissock operated on May 5, 1942. A right frontal osteoplastic flap hinged on the temporalis muscle was turned down, the ventricular fluid was evacuated through a brain needle and the dura was stripped off the roof of the right orbit. After division of the dura along the edge of the lesser wing of the sphenoid the chiasmal region was exposed. It was found that the nerves and chiasm were much pinker than normal and that masses of fine avascular meningeal adhesions were present binding the optic nerves to the overlying brain, to the internal carotid, to the diaphragma sellae and to the anterior part of the chiasm. In addition a thick band of avascular adhesions stretched between the chiasm and the brain. All adhesions were very carefully divided by blunt dissection. There was no hæmorrhage, and no evidence of tumour was seen in the operation field.

Convalescence was uneventful. On May 6, two days after operation, the right vision had improved from hand movements to 5/60 and the left from 6/36 to 5/12. Seven days after operation the patient was up, and I plotted the visual fields. The right eye was then full to 20 and 5 mm. objects on the perimeter, but showed concentric contraction to small objects and a small central scotoma to a 2/2,000 object on the screen. The left eye showed only a slight temporal contraction to small objects on the screen.

Three weeks after operation the vision was: R. 6/60; L. 6/12, and with a small astigmatic correction: R. 6/36; L. 6/9. The visual fields showed no further alteration.

This patient was seen again at the end of September, five months after operation. There had been no deterioration in vision, her headaches were relieved and symptoms of polyuria, polydipsia and polyphagia had cleared up, and her menses had restarted. She had a right-sided anosmia, an almost inevitable result of the operative disturbance.

I did colour fields in all these cases, and while there was contraction of the fields to red and green, the results were no more informative than with the varied sizes of white objects used.

The second case was a man aged 38, a Czechoslovak corporal in the R.A.F. There was nothing relevant in either his family or personal history and he had been perfectly well until June 16, 1941, when he was struck on the right temple by a fragment of shrapnel during a bombing attack on his aerodrome. He sustained a superficial wound and was unconscious for twelve hours. On recovering consciousness he found that with his right eye he could see his hand only when it was held close to his face although the left was unaffected. We could not obtain any information as to his ocular condition at that time. He was kept in bed for seven weeks, after which he suffered from headaches and had a tendency to fall to the left. Since that time he has noticed no change in the right eye, but there has been a progressive deterioration of the left.

When examined on admission to hospital in April 1942 the ocular movements were full and the pupil reactions normal. The right fundus showed generalized pallor of the disc, which was whitish in colour and had clear-cut margins. The vessels were normal in size. The left fundus was normal. The right vision was H.M.s (hand movements); the left 6/60. In the visual fields, the right could be examined only by confrontation with hand movements and appeared grossly contracted. The left, to perimetry, showed a marked pure concentric contraction without scotomata.

In the general examination of the C.N.S. he had right anosmia, partial anaesthesia

of a low grade chronic infection either by direct spread or via lymphatics. As Cushing has pointed out sinusitis may cause meningeal reactions in the chiasmal space just as middle-ear infections can cause reactions in the middle or posterior fossæ, and a meningeal inflammation once started may survive the infection which gives rise to it. Secondly syphilis, excluding tabes, figures as the presumed cause in some 15% of the cases in the French series. The chiasmal lesions here form part of the generalized leptomeningitis for which at any rate preliminary medical treatment is indicated. Schiff-Wertheimer has pointed out that meningeal adhesions around the optic nerves are common in tabetic atrophy, and has reported some cases that have been improved by division of these adhesions. Thirdly, other infections, such as localized tuberculosis or residual meningeal lesions may affect the chiasm, or the disintegration products of pathological processes in the C.N.S. may set up an aseptic inflammation. Finally, trauma appeared to be an operative factor in the second case I have reported, and in the two cases described by Gordon Holmes in 1929. In the French series it figures in 10% of cases. The nature, intensity and point of application of the injury appear unimportant, and in view of the large number of cases of head injury that are seen and the small proportion that develop this trouble it would seem that injury *per se*, acts as a predisposing rather than an exciting cause.

The incidence as given by the French authors is surprisingly high. Of 254 exploratory operations performed on the chiasmal region between 1930 and 1936, 71 cases or 27% were of primary arachnoiditis, and this series does not include presumed cases treated medically. The disease is one of adult life, 60% of cases occurring between the ages of 20 and 40, and males are more commonly affected than females, the ratio being almost 2:1.

The ocular symptoms are usually early and important, but there is no diagnostic pattern. An early complaint is of loss of visual acuity, which may be sudden or gradual and may progress either evenly or with sudden relapses to complete blindness. It is usually unilateral at the start with the second eye failing weeks or months afterwards. The findings of perimetry, as might be expected from the extent of the visual pathway affected, are very variable. In the French series of 129 cases central scotoma was the commonest finding, in 31% of cases, concentric contraction in 23%, temporal loss in 17%, while the other cases showed nasal or horizontal loss or homonymous hemianopia. Temporal hemichromatopsia, common in tumour cases, is said not to occur in arachnoiditis. The fundus appearances also are variable. The French series show primary optic atrophy to be the commonest finding, followed by post-papillitic atrophy, papilloedema and then temporal pallor. In about 10% of cases the fundi are normal. Other ocular signs are rare except in syphilitic cases. Extra-ocular symptoms include severe headache, which as in our first case may precede the eye signs. There may also be symptoms referable to involvement of the infundibulum such as increased appetite, thirst and polyuria, obesity or adiposo-genital dystrophy. General neurological examination is usually entirely negative, as are X-ray of the sella, and ventriculography.

Diagnosis, therefore, is a matter of elimination and involves co-operation between the neuro-surgeon, the rhinologist and the oculist. It is in general based on: (1) Signs of chiasmal or neural involvement. (2) The presence of ætiological factors. (3) The capricious progress with successive exacerbations. (4) The negative findings of X-ray and C.S.F. examinations. Space does not permit of a detailed discussion of the differential diagnosis. Of non-tumour conditions the retrobulbar neuritis of disseminated sclerosis is excluded fairly easily by the pupil reactions, the early functional recovery, disproportion between the functional recovery and the degree of optic atrophy and other factors. Devic's and Schilder's diseases present a typical course after their initial onset. Toxic neuritis is bilateral in its onset and steadily progressive; the fundus remains normal for some time and the ætiological factor is usually discoverable. Except in the early stages of tabes other signs of this disease are present, and the W.R. is helpful. Leber's disease is hereditary and familial and does not progress to complete blindness. Other conditions in this group to be excluded are syphilitic basal meningitis, vascular atrophy and the optic neuritis due to sinusitis. This last debatable condition presents considerable difficulty, but in cases in which clinical sinusitis is present its treatment should obviously precede any exploration of the chiasmal region. Spumous conditions such as meningioma of the olfactory groove, lesser wing of the sphenoid or of the dorsum sellæ, frontal gliomata, pituitary adenomata and craniopharyngiomata, are excluded by X-rays and ventriculography.

#### TREATMENT

Chiasmal arachnoiditis is not a homogenous group; its ætiology is doubtful, and diagnosis is often not made until the late stages and even then is usually confirmed only by operation.

of the first and second divisions of the right fifth nerve, and a partial involvement of the right eighth nerve with some unsteadiness of gait. The X-ray findings were inconclusive and suggested a fracture of the posterior wall of the right frontal sinus running into the anterior ethmoidal cells.

The history and findings here suggested a progressive involvement of the left optic nerve, probably resulting from scar tissue, and operation was thought to be justifiable. Mr. McKissock operated in May, the exposure being the same as in the previous case. He found adhesions between the brain of the frontal lobe and the dorsum sellæ. The right optic nerve was covered by small convoluted vessels and had adhesions binding it to the brain, carotid, chiasm and left optic nerve. There was a loculated collection of fluid between the right nerve and the carotid artery. The left optic nerve and chiasm were similarly surrounded by adhesions, all of which were carefully divided by blunt dissection.

His convalescence also was uneventful, but improvement in his sight, which has been very marked, was less dramatic than in the first case. One week after operation the right vision was H.M.s.; left 6/36. After one month the right vision was 6/60; left 6/12. After ten weeks the right vision was still 6/60, and the left 6/9. Last month, five months after operation, the right vision was the same, but the left had improved still further to 6/5 partly. The right visual field is grossly contracted, but the left has shown a gradual opening out paralleling the improvement in his vision, and is now practically normal.

The third patient was a man of 38, a G.P.O. telephonist, who discovered twelve months before admission that his right eye was weak. He had then consulted an optician and had been comforted by reassurances and a pair of glasses. He gave a history of having been knocked down in the black-out some four months prior to this, when he had been very dazed but not unconscious. He had also had severe headaches for the past year, and had noticed that his left eye had been failing for several months. There was nothing relevant in his family or personal history, nor in his habits.

On ocular examination the only positive findings were some 1.5 D of swelling of both discs without optic atrophy, and reduction of vision in the right eye to H.M.s. and in the left to 6/60. The visual fields in both eyes were full peripherally to 5/330 objects, but in the right eye there was a large central scotoma to 20/330, and in the left eye a small central scotoma to 5/2,000.

Examination of the C.N.S. and of his general condition was negative. X-rays and ventriculography showed a normal sella turcica and no evidence of a space-occupying lesion in the pituitary region. Clinical and X-ray examination of the accessory sinuses was negative as were the W.R. in blood and C.S.F. C.S.F. pressure and chemistry were normal. There was no history to suggest intoxication by tobacco or other poisons.

Here again in view of the length of history and of the negative findings of ventriculography the most probable cause of this man's visual defect was thought to be a chiasmal arachnoiditis, and Mr. McKissock operated in June 1942. The nerves and chiasm were markedly pink and masses of fine adhesions were present involving both optic nerves, the chiasm and the overlying brain. These were carefully divided as in the previous cases, and the wound was closed. Convalescence was again entirely uneventful. The papilloedema subsided rapidly, but unfortunately the patient since operation has shown a progressive deterioration in vision, and in the past few weeks has developed a marked temporal pallor of both discs. The vision in each eye is now only H.M.s., there is concentric contraction of the fields, and absolute central scotomata extending some 15° round the fixation point are present in each eye.

The types of lesion found in chiasmal arachnoiditis are fairly well exemplified in these cases. Arachnoid adhesions bind the optic nerves and chiasm to the brain, to each other, to the great vessels and to the dorsum sellæ. Congestion of vessels is usually present, though the adhesions are often avascular. In the most advanced cases small calcareous plaques have been described. In addition, as in the second case, cysts may be present resulting from loculation of fluid between the adhesions. The nerves themselves may be atrophic or oedematous, or kinked by bands, or show simple congestion. Pathological examination has shown thickening of the pia and arachnoid, vascularity, infiltration by lymphocytes and demyelination and atrophy of peripheral and central nerve fibres. The mechanism by which vision is affected is not entirely clear. It may be that the arachnoiditis and visual disturbances are separate manifestations of an infection, that the arachnoiditis is secondary to a lesion of the nerve fibres, or that visual loss is due to the meningeal changes. The improvement effected by operation suggests that the last is the most likely factor, and if this be so the arachnoiditis may act either mechanically by the direct pressure of adhesions or cysts or indirectly by compression or by causing spasm of blood-vessels.

*Causes of the inflammatory changes.*—Arachnoiditis is a common concomitant of tumours and occurs in close proximity to them. The type we are discussing arises *de novo* and in these cases tumour has been excluded by operation or ventriculography. Owing to their propinquity the accessory nasal sinuses have been indicted as the source

## Section of Neurology

President—R. M. STEWART, M.D.

[December 17, 1942]

### THE NEUROLOGICAL COMPLICATIONS OF MALNUTRITION

#### Psychic Manifestations of Nicotinic Acid Deficiency

By V. P. SYDENSTRICKER, M.D.

THERE are a number of psychic disturbances of widely varying patterns which are relieved or cured by the administration of nicotinic acid. While the actual experimental proof of the specific effect of nicotinic acid deficiency in producing mental disorder is lacking, the clinical evidence for such an effect is very strong. The influence of deprivation of other vitamins of the B group on the clinical picture is not known, though there is some reason to suspect that thiamin deficiency may be important.

The incidence of nutritional psychosis in any locality depends on the general nutritional state of the population. Where gross deficiency diseases are endemic, it is encountered frequently; elsewhere it is apt to be seen only in the alcoholic, the aged poor, and individuals depleted by illness and certain therapeutic procedures. Like almost every manifestation of illness due to deprivation of vitamins of the B group, the neuropsychiatric symptoms are not specific. They can simulate neuroses and most of the well-known functional, toxic, and organic psychoses. In fact diagnosis frequently depends on therapeutic test rather than on any characteristic symptoms or signs.

To correlate the motley group of clinical pictures which respond to vitamin therapy it is necessary to present tentatively the hypothesis that chronic partial deficiency produces functional and anatomical changes of quite a different order from those caused by rapid or acute, and perhaps total, depletion of vitamin reserves. In the case of nicotinic acid, it seems that partial deficiency lasting for many months or years produces functional or biochemical disturbances which are relatively mild, but in the course of time lead to anatomical changes which may be irreversible. On the other hand, complete, or almost complete, depletion rapidly produced causes severe, even fatal functional disturbances, often with no gross anatomical lesions. The regularity with which psychic symptoms accompany deficiency of nicotinic acid, and perhaps other vitamins concerned in the production of the "pellagrous state", has an apparent explanation in the coenzyme activity of nicotinic acid, riboflavin, and thiamin in the processes of cellular respiration and nutrition. In theory, the high requirement of cerebral neurones for oxygen and carbohydrate makes them more susceptible than other cells to failure of coenzyme function.

In classical pellagra, whether endemic, "alcoholic", or due to organic disease of the gastro-intestinal tract, psychic disturbances may precede any other manifestations by weeks or months—this in primary attacks as well as relapses. Frequently the complaints are so typically neurotic that patients get small sympathy, though the relapsing pellagrin is apt to recognize their significance and come, not so much complaining of his symptoms, as predicting the relapse they herald. Lassitude, slight mental retardation, loss of memory for recent events, apprehension, and a tendency to confabulation are common. Depression and mild delusional states without marked loss of insight may develop. It will be noted that many of these symptoms are similar to those noted by Williams and his collaborators (1940) in experimentally produced B<sub>3</sub> deficiency. In the pellagrin, however, we have not seen improvement follow the administration of thiamin. In addition to purely psychic symptoms are others such as insomnia, headache, vertigo, and paræsthesias of various types. It is possible that these are related to early organic changes. As the disease progresses, characteristic glossitis and dermatitis make their appearance. After several relapses the mild psychoses are replaced by marked disorientation, hysterical and confusional episodes, and sometimes actively maniacal states. In the end a great number of patients treated before nicotinic acid was available became seriously and permanently

For medical treatment mercury and iodides have been suggested on general grounds, whether or not the cases are syphilitic. The treatment of infection in the nasal sinuses is of importance, but the efficacy of medical or rhinological treatment will depend on the anatomical conditions around the nerves and chiasm. If these are still in the stage only of oedema or vascular spasm, resolution is possible, but with definite cicatrization it is difficult to see what benefit will accrue.

Direct surgical intervention has passed through two stages, the first an incidental one in the exploration of a supposed tumour, the second, elaborated by Vincent, undertaken as a definite therapeutic measure with the object of freeing all adhesions present. This must, of course, be done as carefully as possible to avoid forming a starting point for fresh adhesions.

Mortality from the operation in skilled hands is small. In Vincent and Puesch's series there were seven deaths in 95 cases of operation on this region, of which three occurred before their operative technique had been fully elaborated. Of the survivors 28% showed permanent improvement of vision. It is pointed out that many cases show an immediate improvement followed after three to four weeks by progressive deterioration, but that relapses later than one month after operation are rare. It would seem advisable to continue the treatment of any particular aetiological factor found, such as sinusitis or neurovascular syphilis, after the direct attack on the chiasmal region.

The improvement is seen, as in our first two cases, in the visual acuity and the fields of vision. The fundi except in cases with papilloedema show no change, as one would expect. The extraocular symptoms of headache and diabetes insipidus are usually much ameliorated. A permanent anosmia usually confined to the right side, results from the operation, but if successful most patients will agree that recovery of function in the second cranial nerve will compensate for its loss in the first.

While the French authors are most enthusiastic about the prospects surgery holds out for this condition, our knowledge of its pathogenesis and diagnosis does not yet rest on sure foundations, and much remains to be elucidated especially in regard to its relationship to nasal sinusitis. The presence of arachnoid adhesions has been described in Leber's disease and, as I have mentioned, in tabes dorsalis. To what extent their action can be blamed for the visual loss in these diseases yet remains to be worked out.

In conclusion I must express my thanks to my colleague, Mr. Wylie McKissock, in whose department these cases were investigated and treated and who has allowed me to make use of his case records and operation notes.

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seem very likely that stupor and the more striking encephalopathic syndrome are stages in the development of Wernicke's disease. Korsakow's psychosis is closely simulated by the delirium of some patients who definitely fall into the group described by Cleckley, and it must be said that it is quite questionable whether the occurrence of Korsakow's psychosis should be requisite for the diagnosis of Wernicke's syndrome. The peripheral neuropathy of classical Wernicke's disease is probably due to thiamin deficiency; in fact, it is at present impossible to differentiate accurately the effects of thiamin deficiency when it occurs as part of severe avitaminosis of the whole B group.

The diagnosis of the stuporous and encephalopathic states due to malnutrition is not in a satisfactory state, since therapeutic administration of vitamins remains the only certain and convenient test. The mental status, indeed the whole picture, cannot be differentiated with certainty without a most complete examination. Frontal lobe tumours, cerebral metastases from visceral carcinoma, cerebrospinal syphilis, vascular disease of the brain, brain abscess, chronic subdural hæmatoma, and bromide intoxication are some of the more important conditions to be eliminated. Positive tests for vitamin deficiency in the absence of gross physical signs are few and specialized. Absence of the fluorescent substance  $F_2$  (Najjar, 1941) from the urine, particularly if the substance  $F_1$  is present in large amounts, has been the most helpful test we have tried. The nature of  $F_2$  is unknown, but it is related apparently to the excretion of nicotinic acid or allied pyridine derivatives. It seems likely that the newer methods of determining trigonelline and nicotinic acid amide in the urine may also be very useful.

The management of the entire group of psychoses under discussion is relatively simple. Feeding is of prime importance and for several days a liquid diet of milk, eggs, cereal gruels, and vegetable purées may be given by stomach tube. As soon as co-operation is secured, the diet should be as full and abundant as can be taken. It is often possible to add marmite or other yeast extracts to liquid food. Hydration frequently must be maintained by parenteral infusion of glucose and saline solutions. Very large amounts of nicotinic acid are required during the first few days of treatment. It is our custom to give 100 mg. of nicotinic acid or 30 mg. of nicotinic acid amide every hour for ten hours during the first two days, continuing this dosage longer if necessary. The vitamin can be added to intravenous or subcutaneous infusions or given intramuscularly. The great majority of patients show great improvement within forty-eight hours after treatment has been started. Once improvement is definite the daily doses of nicotinic acid can be reduced to 500 mg., and of the amide to 150 mg. It is preferable to give these amounts in four or five aliquots equally spaced through the day. Later the oral administration of 25 mg. of nicotinic acid three times daily should suffice for maintenance. Whenever there are signs of peripheral neuropathy, and perhaps in every instance of the stuporous and encephalopathic states, thiamin should be given with the nicotinic acid. It is our custom to give thiamin in an amount equal to one-tenth the nicotinic acid which is used. This dose is empirical and probably wasteful, but seems effective. The question of the use of other vitamins is entirely open. We have no knowledge that other members of the B group are required in amounts larger than can be obtained from food and yeast. Certain results obtained in instances of Wernicke's syndrome suggest that, in this condition at least, the whole B complex hastens cure. Using an injectable mixture of 50 mg. of nicotinamide, and 5 mg. each of thiamin, riboflavin, pyridoxine, and calcium pantothenate, given six times daily, we seemed to get more rapid improvement than with nicotinamide and thiamin alone. The addition of yeast, 15 to 30 g. daily, to the diet should not be omitted, regardless of the crystalline supplements used. This amount of yeast can be taken as compressed tablets or as dried brewers' yeast stirred up in milk or cocoa.

It has been suggested that the vasodilator effect of nicotinic acid may be important in relation to the very rapid and striking improvement so often seen in the elderly arteriosclerotic patients suffering from the stuporous or encephalopathic states. At present it cannot be said that this pharmacologic effect is unimportant. Certainly nicotinic acid causes active vasodilatation in the meninges of normal dogs with increase in brain volume, doubtless due to increased amounts of blood in the cerebral vessels. In both stupor and encephalopathy, however, nicotinamide and coramine (the diethyl amide of nicotinic acid) produce cure quite as rapidly as does nicotinic acid. Neither of these substances has any appreciable vasodilator effect.

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psychotic, with either a profound depression or a paranoid state. A majority of such persons have failed to respond to any form of therapy, probably because of actual destruction of cerebral neurones. During earlier stages of mental dilapidation, the administration of adequate amounts of nicotinic acid has produced dramatic improvement amounting to complete cure in the great majority of instances. As has been stated, cure has not followed even prolonged use of nicotinic acid in severe psychoses of long duration, though some improvement in behaviour has been noted, particularly in the paranoid group.

Of much more importance than the pellagrous psychoses are those which have been referred to as the result of acute avitaminosis. Some of these fall into the classifications "toxic psychosis", "exhaustion delirium", and "psychosis, cause undetermined". They are seen frequently in general hospitals and occur not uncommonly after surgical operations or after delivery. In the great majority of instances there is no history of deficiency disease, or even of serious dietary inadequacy, though a small number of such patients are alcoholic. Some have been subjected to dietary restriction for the treatment of gastrointestinal diseases; others have had their metabolic demands increased by the fever of infection. Many have for a number of days received intravenous infusions of glucose as the chief or only source of nourishment. The onset of delirium, hallucinations, or mania is abrupt, or after a very short period of confusion. Physical signs of deficiency disease in the usual sense of the term are absent. Frequently the tongue is dry, clean, and red, but without atrophy of papillae, a so-called "toxic tongue". Rarely there is acute stomatitis and glossitis with an abundance of Vincent's organisms. The response of the mental symptoms to nicotinic acid or nicotinamide is very rapid and complete, frequently within twenty-four hours after administration is started. It is supposed that all such patients must have been in a borderline state of nutrition for some time. The administration of vitamin-free calories in the form of glucose presumably exhausts the scanty reserves of nicotinic acid in the body. It is probable that thiamin is similarly depleted, but the evidence of its lack is not so striking as is that of nicotinic acid.

Quite a different series of manifestations of severe, but possibly less acute, nicotinic acid deficiency has been described by Cleckley (1939) and by Jolliffe (1940). Little is known of the histopathology of the brain in these cases, but it would seem likely that both authors were dealing with conditions which cannot be differentiated from Wernicke's syndrome. The report from my clinic (1939) described a type of patient rather commonly encountered in general hospitals: usually old and living alone, the person is found unconscious and brought to a hospital. Profound stupor or stupor alternating with delirium and variable reflex changes are the presenting phenomena. Quite regularly there is evidence of underfeeding, though definite signs of avitaminosis are rare and confined to occasional instances of glossitis. The age of the patient, the presence of peripheral arteriosclerosis, and the mental state ordinarily result in the wholly justifiable admitting diagnoses of cerebral thrombosis or of uræmia. None of the patients in this group had signs of involvement of the brain-stem, nor was peripheral neuropathy noted. In the ordinary course of events such a patient was subjected to the intravenous injection of large amounts of glucose solutions in efforts to maintain hydration during the period when diagnostic tests were being carried out. Nothing particularly informative being found, even after prolonged and exhaustive examination, treatment with glucose and stimulants used to be continued until the patient succumbed on the fourth or fifth day to "terminal bronchopneumonia". Treatment of this high mortality group of patients with nicotinic acid was at first quite empirical and begun because one such person had a red atrophic tongue. In this condition, as in the acute psychoses already described, the results of the administration of nicotinic acid have been quite remarkably good.

Jolliffe (1940) reported an encephalopathic syndrome characterized by clouding of consciousness, cogwheel rigidities, and uncontrollable grasping and sucking reflexes. Many of his patients had evidence of involvement of the mid-brain and some had peripheral neuropathy. About half had clinical evidence of pellagra, and all were alcoholic. The mortality in the group showing the syndrome was 89.4% when treatment was limited to feeding and use of dextrose and saline solutions; a small number received thiamin in addition and all these died. When nicotinic acid was added, the mortality was reduced to 13.6%. Jolliffe concluded that this syndrome represented the extreme picture of nicotinic acid deficiency, probably with acute deprivation superimposed upon a prolonged partial avitaminosis. We have observed a number of instances of this encephalopathy and can confirm the striking effects of nicotinic acid in promoting rapid cure. We have also seen patients in whom stupor alone was found on admission, and who developed the cogwheel rigidities and grasping and sucking reflexes while hospitalized. Also we have seen ophthalmoplegia and loss of tendon reflexes appear without the rigidities or "foetal" reflexes. It would

the U.S.A. have studied the histological changes in vitamin B<sub>1</sub> deficiency with great care. For instance, Swank (1940 *et seq.*) has shown that in pigeons acute deficiency produces opisthotonos with only a few or no degenerating fibres in peripheral nerves or the central nervous system; on the other hand, chronic deficiency produces first locomotor ataxia due to proprioceptive loss, and then leg weakness with degeneration of peripheral nerves. The axone is first involved at its most distant point, degeneration progresses centrally with sclérosis or shrinking of the cell body, and degeneration of the myelin sheath follows secondarily; the largest fibres are affected first, and the smallest are usually untouched. Therefore pain, due to impulses in "C" nerve fibres, may be a prominent feature. Starvation produces demyelination but no axone degeneration. Swank believes that the hæmorrhages found in the lower parts of the brain are secondary to degenerative changes in the neurones surrounding blood-vessels and are caused by accumulation of acid metabolites. Similar results have been obtained by Street and others (1941) in dogs.

During the last war Walshe concluded that the polyneuritis of birds fed exclusively on polished rice was analogous with beriberi in every respect, and shortly before this war Vedder concluded that nerve changes occurring in polyneuritis gallinarum were precisely similar to those occurring in human beriberi; it is therefore legitimate to apply the results obtained by Swank and others cautiously to disease in man. Unfortunately there is little clear-cut evidence of the role of vitamin B<sub>1</sub> in human multiple symmetrical peripheral neuritis, partly because a diet is unlikely to be deficient only in vitamin B<sub>1</sub>, and partly because vitamin B<sub>1</sub> stimulates appetite and therefore it is difficult to be sure that therapy has been confined to that one vitamin alone. In recent experiments in which human volunteers have been placed upon diets deficient in vitamin B<sub>1</sub>, neurasthenia but not neuritis has been produced; it is probable from animal work that such experiments have not been sufficiently chronic.

One of the most satisfactory methods of assessing deficiency is to estimate vitamin B<sub>1</sub> or its phosphorylated form (cocarboxylase) in blood, and results of these estimations obtained in Oxford were communicated to the Neurological Congress just before war broke out (Sinclair, 1939; Goodhart and Sinclair, 1939). It seems likely that nutritional, alcoholic and gastrogenous polyneuritis are accompanied by deficiency of vitamin B<sub>1</sub>, and that the same is true of some cases of diabetic and of gestational polyneuritis. The neuritis that may accompany poisoning with certain sulphanilamide derivatives seems to be closely associated with conditioned deficiency of vitamin B<sub>1</sub>; but diphtheritic, arsenical and other toxic forms have no direct relation. However, just as deficiency of vitamin B<sub>1</sub> produces neuritis by interfering with the utilization of pyruvate in neurones, so many of the toxic forms may be produced by a similar biochemical lesion; arsenic, for instance, is known to interfere with the oxidation of carbohydrate in a similar way to deficiency of vitamin B<sub>1</sub>. But other important factors may come into the picture: for instance, arsenic and alcohol interfere with the conversion in the liver of vitamin B<sub>1</sub> to its coenzyme form. Obviously any agent acting solely in the same way as deficiency of vitamin B<sub>1</sub> should produce the same neurological signs and symptoms and an increased concentration of lactic and pyruvic acids in blood. Therefore close attention should be paid to the clinical manifestations of such neuropathies: the condition should be symmetrical, first affecting the long nerves distally, and pain (including calf-tenderness due probably to an accompanying myopathy) should be a prominent feature. The derangement of carbohydrate metabolism will be revealed by an analysis of lactic or pyruvic acids in blood or urine; but such a derangement has been indicated by this criterion in beriberi, poisoning with arsenic or phosphorus, pernicious vomiting of pregnancy, eclampsia and particularly eclamptic fits, cyclical vomiting in children, acute yellow atrophy of the liver and diabetes.

The value of such biochemical tests was recently shown by the work of Grande and Jiménez (1942) in cases of neuropathy occurring during the siege of Madrid: they found that lactic acid was used in a normal way and therefore concluded that deficiency of vitamin B<sub>1</sub> was not an important factor in the genesis of the neuropathies they studied. Grande classified such conditions into five groups: paræsthesiæ, paræsthesiæ with causalgia, retrobulbar optic neuritis, funicular myelopathy and cochlear neuritis; these syndromes were often accompanied by the skin manifestations of pellagra. The diet of the inhabitants of Madrid consisted mainly of bread, lentils, a little rice and garlic soup, and was not especially low in vitamin B<sub>1</sub>; pellagra was extremely common although beriberi was rare. The neuropathies were not curable with vitamin B<sub>1</sub>, nicotinic acid or vitamin A, but were cured by administration of yeast.

This raises the question of other members of the vitamin B complex being concerned



## Malnutrition and Peripheral Neuropathies

By H. M. SINCLAIR, D.M.

NEUROLOGICAL conditions that are alleged to respond to vitamin therapy are many and varied. Unfortunately it is difficult to get clear-cut evidence of the role of vitamin deficiencies in the aetiology of such conditions, because the diet of the patient is seldom deficient in one factor only and because therapy with a single vitamin is seldom practised or justified. Our evidence derives mainly from laboratory experiments, and arguing from lower animals to man is notoriously dangerous. At least four vitamins have been incriminated: A, E, B, and riboflavin.

### *Vitamin A: Bone and Nervous System*

Mellanby (1926, 1931, *et seq.*) first showed that degeneration of the nerves in the central and peripheral systems was caused by deficiency of vitamin A in certain animals. Later it was suggested that such deficiency in man might produce nerve degeneration, and therefore such conditions as xerosis conjunctivæ, night blindness, retrobulbar neuritis, neuritis of beriberi, and subacute combined degeneration of the cord; but the belief that the epithelial metaplasia of vitamin A deficiency is due to nerve degeneration has now been disproved by Sauer (1939). Hart in 1937 showed that bony overgrowth in animals in vitamin A deficiency could cause blindness, and Mellanby (1938) showed that it could also produce deafness in puppies owing to overgrowth of the labyrinthine capsule; in 1941 he obtained similar effects even in adult animals. This bony overgrowth has recently been studied by Wolbach and Bessey, who have concluded that if vitamin A deficiency is established at a sufficiently early age skeletal growth stops, but the central nervous system and other soft tissues continue to grow; there is overcrowding of the cranial cavity and cord, and herniation into the venous sinuses of the dura and intervertebral foramina; and there is therefore mechanical damage with subsequent irregular degeneration of nerve roots, peripheral nerves and nerve fibres in various tracts of the spinal cord and brain, but without impairment of the reparative powers of neurones. They therefore believe that the nervous lesions of vitamin A deficiency are wholly mechanical in origin.

### *Vitamin E and Myopathies*

Evans and Burr (1928) were the first to show that suckling rats developed paralysis if their mothers were kept on a diet deficient in vitamin E, and the subsequent work on animals culminated in the suggestion of Einarson and Ringsted (1938) that amyotrophic lateral sclerosis and tabes dorsalis might be due to deficiency of the vitamin. Very recently Wolf and Pappenheimer have failed to obtain any central nervous changes in rats on a diet deficient in vitamin E, and it seems probable that such deficiency produces a primary myopathy which is similar pathologically to Zencker's degeneration in muscle; regeneration occurs if the sarcolemma survives. The hypothesis of Einarson and Ringsted was tested clinically by Bicknell and by Wechsler independently; they believed that certain cases of myopathy and of amyotrophic lateral sclerosis were deficiency diseases and curable. Later, when this therapy began to totter, various members of the vitamin B complex were enlisted to support it, and the patients loyally said they felt better. At the present time there are about two negative papers published for each one that claims positive results of therapy. The difficulty of assessing clinical improvement, particularly amid remissions, is great, and probably accounts for these divergent results. A better test is a biochemical one: in rats and rabbits with nutritional myopathy there is an increased excretion of creatine which falls steeply when vitamin E is given; the four groups of workers who have tested this in man (Ferrebee *et al.*, Vivanco, Fitzgerald and McArdle, Alpers *et al.*) have all shown that there is no effect of such therapy on this biochemical disorder in man.

### *Vitamin B Complex and Peripheral Neuropathy*

Vitamin B, is the most important vitamin to be considered from the point of view of peripheral neuropathies, but unfortunately much of the early work dealing with its deficiency in animals was untrustworthy because the effects of inanition or deficiencies of other vitamins were not properly controlled. Recently several groups of workers in

## Clinical Section

President—PHILIP TURNER, M.S.

[November 13, 1942]

MEETING HELD AT ST. BARTHOLOMEW'S HOSPITAL, LONDON

**Chronic Constrictive Pericarditis after Operation.**—G. H. JENNINGS, M.D., and J. E. H. ROBERTS, F.R.C.S.

K. P., female, aged 17. No previous illness.

August 1941: First noticed abdominal swelling, gradually increasing in size, also gradually increasing shortness of breath on exertion.

April 1942: Admitted to Redhill Hospital under Dr. Jennings. Paracentesis abdominis, 13 pints 16 oz. Kymogram showed little cardiac movement.

May 26, 1942: Admitted to Hill End Hospital, St. Albans, under Mr. Roberts. Neck: External jugular veins distended to angle of jaw when sitting up. Chest: Feeble apex beat 4th space mid-clavicular line. Area of cardiac dullness not enlarged. No added sounds. No abnormal physical signs in lungs, but liver dullness extended up to 4th rib. Arms: No clubbing of fingers. No capillary pulsation. Abdomen: Shifting dullness. Liver not felt ( $1\frac{1}{2}$  fingers below costal margin after paracentesis), spleen palpable. Legs: No œdema of ankles. Blood-pressure 118/86. Venous pressure (at ante-cubital vein)  $24\frac{1}{2}$  cm. water. Arm to tongue circulation time for ether—eight seconds.

July 2, 1942: Operation for pericardectomy by Mr. J. E. H. Roberts under cyclopropane anaesthesia by Mr. Rait Smith (no endotracheal tube). The 3rd, 4th and 5th costal cartilages and portions of ribs were removed. The thickened pericardium was removed from the anterior surface and left border and apex of the heart. To the right the heart was freed to the mid-line of the sternum. The pleura was opened and was not sutured, thus allowing drainage into the pleural cavity. The wound healed cleanly. Blood-stained effusion was aspirated once from the pleura.

August 23, 1942: On discharge the ascites had disappeared, the liver was not palpable. The veins in the neck were still slightly distended on lying flat. Kymogram now shows good movement of the heart on the left border, and increased movement on the right side, but not so much as on the left.

November 13, 1942: Patient can run without dyspnoea and is earning her living as a shop assistant.

**Patent Ductus Arteriosus Complicated by Subacute Bacterial Endarteritis Treated by Ligation of the Ductus.**—OSWALD S. TUBBS, F.R.C.S.

Mrs. E. B., aged 22, card-painter. Well till five months ago when she had three teeth extracted—felt weak for three days subsequently but returned to work after one week. Four months ago again felt weak—attended doctor who said she had valvular disease of the heart and anaemia. Subsequently had three attacks of pleuritic pain in the right side of the chest at approximately monthly intervals and felt short of breath; amenorrhoea during these four months. For two weeks was listless and had severe palpitations; fever varied from 98° to 103° F. Admitted King George Hospital, Ilford, 13.3.42—given blood transfusion (3 pints).

*Previous history.*—Childhood activities normal—never “blue”.

*On examination.*—Pale. T. 103.6°. P. 90. R. 20. No petechiae. Slight impairment of movement, percussion note and breath sounds at right base. Heart: Systolic and diastolic thrills in pulmonary area. Apex beat 5 in. from mid-line in 5th space. Rough systolic and diastolic murmurs at pulmonary base, typical of patent ductus arteriosus. Blood-pressure 122/58. Spleen not palpable. Urine: Guaiac test positive.

Blood culture (Dr. R. H. A. Swain): 56 colonies of *Streptococcus viridans* per c.c. Haemoglobin 60%. Haldane. W.B.C. 8,000. X-ray chest (6 ft. film): Fullness upper

in such conditions. Retrobulbar neuritis has been noted lately in deficiency states (Moore, 1939; Landor and Pallister, 1935; Wilkinson, 1941); it also occurs in pernicious vomiting of pregnancy (Ballantyne, 1941). There is dimness of vision at first, but no visible change in the fundus; next there is a central scotoma with some oedema of the disc, and later still complete loss of vision that is usually curable by the administration of yeast. Neither vitamin B<sub>1</sub> nor nicotinic acid is concerned in this condition and deficiency of riboflavin is the most likely cause.

It is clear that our knowledge of these conditions is as yet meagre, and that they will only be elucidated by further critical clinical work, combined where possible with biochemical tests. As a generalization it may be said that the encephalopathic states described by Dr. Sydenstricker in the preceding paper are due to acute vitamin deficiencies, whereas the peripheral neuropathic states are caused by chronic deficiency. Such chronic deficiency tends to produce other accompanying signs and symptoms. Deficiency of vitamin A, if produced acutely, probably first causes a diminished power of dark adaptation, and at the same time there is a fall in vitamin A and carotene in blood plasma; chronic deficiency is accompanied by follicular hyperkeratosis, particularly over the triceps and the anterolateral parts of the thighs, and there are also conjunctival and corneal changes. Acute deficiency of vitamin B<sub>1</sub> in man probably causes the cardiovascular lesions of beriberi, and chronic deficiency the neuritis, but such deficiency can probably first be detected by analyses of blood either for vitamin B<sub>1</sub> or for pyruvic acid. Deficiency of riboflavin, as has been shown by Dr. Sydenstricker and his colleagues, causes vascularization of the cornea, but it is probable that flattening of the filiform papillæ of the tongue is an even earlier change. It is clearly important to make a complete clinical examination of the patient, when possible combined with biochemical tests, if deficiency is suspected; and it would be rare to find deficiency of one factor alone.

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stomach. Mercury bougie passed; resistance at 15 in., suddenly overcome by slight pressure. No attack during next week. Bougie then passed under X-ray screen; bougie seen to be curled up inside œsophagus; impossible to introduce through cardia. When œsophagus half full of barium dyspnœa commenced and swelling appeared in neck; some barium vomited, attack stopped suddenly.

Thereafter: Six attacks instantly cured by emptying œsophagus of 300 to 400 c.c. fluid. Attempts to dilate œsophagus via œsophagoscope failed.

8.10.42: Discharged; œsophageal wash-outs arranged thrice weekly.

Since then: No further attacks; weight steady.

Dr. PARKES WEBER said that the œsophageal enlargement (megœsophagus) connected with "cardiospasm" or "achalasia" might be of three main types: (1) Simple fusiform; (2) sac-like, with a baggy or sac-like enlargement surrounding the lower orifice; (3) twisted. The bending or twisting was due to enlargement in length as well as in breadth—a necessary kind of natural adaptation. In the second and third types the coiling of a rubber stomach-tube in the œsophagus constituted a misleading source of danger. In the third type (if not in the others also) the megœsophagus seemed to be (at least potentially) congenital and increased gradually with the patient's age, without obvious symptoms, until a stage was reached when decompensation occurred, as shown by dyspnœic and cardiac attacks. In such attacks the careful withdrawal through a tube of œsophageal contents should be regarded as an emergency measure.

#### Artificial Pneumoperitoneum Demonstrating Eventration of the Diaphragm.—E. W. BINTCLIFFE, M.S., F.R.C.S.

*History of case.*—J. V., aged 36, a private in the Belgian army, was admitted to hospital on May 15, 1942, having previously been in perfectly good health. In February 1942 while crossing the Atlantic he had an attack of hæmoptysis. Since then he has had three recurrences. He has also had a cough with mucoid sputum. He has lost weight and appetite. There has been a dull pain beneath the left costal margin for two months.



FIG. 1.—Preliminary antero-posterior view showing swelling in region of left cupola of diaphragm.

*On examination.*—Slight obesity. Chest: No abnormal physical signs except a slightly impaired percussion note at the extreme left base. Abdomen: Patient complained of pain round the left costal margin especially on deep breathing and was slightly tender on palpation in this region. Other systems normal.

part of left heart border: consistent with patent ductus arteriosus (Dr. G. Simon). Sulphanilamide 1 g. four-hourly commenced 25.3.42—stopped 31.3.42. Blood culture on 30.3.42 yielded 70 colonies of *Streptococcus viridans* per c.c.

27.3.42: Blood transfusion 1,000 c.c.

2.4.42: Ductus ligatured—actual ligation of vessel obtained at 11 a.m. Blood cultures obtained on this day gave following readings: 9.45 a.m., 130 colonies per c.c.; 11.45 a.m., 26 colonies per c.c.; 3.15 p.m., 8 colonies per c.c.; 6.15 p.m., 5 colonies per c.c.

3.4.42: 2.45 p.m., 1 colony per c.c.

13.4.42: Cultures sterile.

More rise of temperature, pulse and respiration rate during first four days after operation than usual—? due to collapse of left lower lobe. Upper trunk brachial plexus syndrome present. On fifth day after operation, sudden pleuritic pain left chest, T. 102° and blood culture yielded 2 colonies of *Streptococcus viridans* per c.c. Subsequently afebrile. Diastolic blood-pressure never less than 70 after operation. Discharged 24.5.42, well except for brachial plexus lesion. Thrill and murmurs due to patent ductus absent. Has remained perfectly well since; brachial plexus lesion completely disappeared.

Dr. F. PARKES WEBER thought that a patent ductus arteriosus, just as a congenital valvular malformation or the scar from an old rheumatic endocardial lesion, was a *locus minoris resistentiae* towards any streptococci which might chance to be in the circulating blood (for instance, from a dental source). The local want of resistance in the ductus arteriosus was probably due to defect of some kind in the endothelium and subendothelial blood-vessels. He suggested that the reason why the operation of ligation was so quickly followed by disappearance of *Streptococcus viridans* from the blood-stream, was that the ligature, by closing up this surface of imperfect endothelium, deprived the streptococci of their breeding ground (or most of it).

## Two Cases of Myasthenia Gravis.—H. V. MORGAN, M.R.C.P.

Two cases of myasthenia gravis were shown in whom the function of the respiratory muscles had been studied by means of spirometer tracings. The vital capacity was used as a measure of the power of the respiratory muscles. It was found that in both cases the vital capacity was diminished—1,750 c.c. and 2,100 c.c. respectively. After an injection of prostigmine the vital capacity increased in both cases to approximately 3,000 c.c. By repeated vital capacity readings which were plotted on a curve the degree and duration of the effect could be determined.

It was found that the effect of prostigmine lasted five to six hours, and that if a second injection were administered an exactly comparable curve would be obtained.

The action of various drugs was compared by this technique. Ephedrine and potassium chloride were each found to produce an increase in the vital capacity; but this increase was less than that produced by prostigmine. The vital capacity produced by exhibiting all three drugs was greater than that obtained from any one of them alone, and the increase in each case varied directly with the dose of the drug.

The technique was used to work out the optimal doses of drugs for the patient, and in one of these cases, in whom the vital capacity had been followed for two years, it was possible to demonstrate a marked deterioration in the response to prostigmine.

## Cardiospasm with Attacks of Cardiac Asthma.—JAMES T. HAROLD, M.D., M.R.C.P.

Mrs. A. P., aged 67.

Admitted 4.8.42, having collapsed.

*Past history.*—For two years: Periodic attacks of dyspnoea by day, not related to exercise; attacks persisted five to twenty minutes and terminated with eructation of wind. Flatulent dyspepsia many years. No other symptoms. Weight stationary.

Two hours before admission: A very severe attack of breathlessness lasting one and a half hours which abated before arrival.

*On examination.*—Tired; no cyanosis, dyspnoea, orthopnoea or congestion. Pulse 90; volume very full. Blood-pressure 170/120. Left heart ++. Gallop rhythm.

Next day: Severe attack of breathlessness with grave circulatory failure lasting thirty-six hours; patient semiconscious and moribund. No relief from any form of therapy. After thirty-six hours condition suddenly abated without eructation or vomiting.

During attack trachea observed to be prominent. X-ray chest: opacity upper mediastinum with fluid level. Barium swallow: large tortuous œsophagus; some barium entered

poor filling was obtained, owing to the nervousness of the patient. A barium meal showed a normal stomach and colon, neither of which appeared to enter the shadow in the recumbent position. A pneumothorax was induced and showed the shadow to be separate from the lung (fig. 2). A pneumoperitoneum showed the spleen could be clearly defined lying across the base of the shadow when 200 c.c. of air was introduced. After 600 c.c. the shadow was seen to be completely filled with air, showing what appeared to be a large eventration of the diaphragm (fig. 3). There was no paradoxical movement of the diaphragm on the affected side but the shadow increased in size when the diaphragm descended on inspiration and decreased in size on expiration.

*Comment.*—Pneumoperitoneum is an investigation which is not very frequently performed, and to which there are few references in the literature. Mr. J. E. H. Roberts was I believe the first in this country to use the method, which he described in an article published in the *British Medical Journal* in November 1920. Other articles by Carelli in 1923 and Zeitlin in 1930 have appeared in American journals of radiology. By using larger quantities of air or oxygen and taking radiographs in different positions most of the solid viscera of the abdomen can be visualized and the induction of pneumoperitoneum is also likely to be of especial value in the investigation of affections of the diaphragm.

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[December 11, 1942]

#### MEETING AT ST. THOMAS'S HOSPITAL, LONDON

**Xanthomatosis—Probably Familial.**—H. J. ANDERSON, M.B.

D. M., female, aged 60. Attended hospital 1921 with painless nodules on hands; diagnosis gout; treatment colchicum and courses of atophan.

Complained, 1933, of attacks of pain in the chest (mid-sternal region, radiating to the left side of the back in the areas of the 6th and 7th dorsal roots and to the left arm) the condition being induced by exertion and relieved by rest; attacks more frequent recently and associated with breathlessness.

*Family history.*—Sister attended hospital suffering from painful nodules at age of 35; biopsy report (the late Professor Dudgeon): "Considerable fibrosis only"; subsequently developed angina of effort and died aged 60.

Two brothers dead—no history of nodules. One sister, aged 59, alive and well. Father died at 58, cirrhosis of liver. Mother died of dropsy and cardiac failure.

*Examination findings.*—Firm, painless nodules, yellow-pink in colour, on extensor tendons of hands and arms, on patellar tendons, on extensor tendons and in soles of both feet and on the right and left tendo achillis. Palms of hands normal. Eyes show yellow-grey deposit at the site of trauma sustained in childhood. Skin—no xanthomatous rash deposit. Blood-pressure 190/110. Electrocardiogram, left axis deviation but curves otherwise normal. Radiological examination of skull, hands and spine, nil abnormal. Serum cholesterol: 400 mg. %.

Blood sugar curve: Resting, 0.109%;  $\frac{1}{2}$  hour after 50 g. glucose, 0.146%; 1 hour after 50 g. glucose, 0.146%; 2 hours after 50 g. glucose, 0.104%;  $2\frac{1}{2}$  hours after 50 g. glucose, 0.062%.

Urine: No sugar or acetone.

Blood uric acid: 2.20 mg. %.

*Progress.*—Anginal syndrome relieved by nitrite medication; no dietetic treatment; no change in nodules.

Dr. F. PARKES WEBER thought that a striking feature was the complete absence of cutaneous xanthoma—that is, of all xanthoma in the original use of the term. In this case of symmetrical xanthomatosis of tendons, tendon-sheaths and fasciæ, the constitutional nature of the condition was shown by the symmetry, the high blood cholesterol and the record of the patient's sister. In both sisters there was atheromatosis (evidenced by the angina pectoris) as well as xanthomatosis. He wondered whether a diet poor in fat, and particularly in cholesterol, would be of any use in such cases.

*Investigations.*—Sedimentation rate 4 mm. in one hour. Sputum negative for tubercle bacilli. Blood-count: Hb. 101%; R.B.C. 4,860,000; C.I. 1.03. Leucocytes 10,600. Differential count normal.



FIG. 2.—Diagnostic pneumothorax showing partial collapse of the left lung leaving the swelling unaffected.



FIG. 3.—Pneumoperitoneum after introduction of 600 c.c. of air which has filled the swelling and the left dome of the diaphragm.

X-ray examination: An X-ray of the chest (fig. 1) showed a dome-shaped shadow above the left diaphragm. The splenic shadow was lying below this. No evidence of pulmonary tuberculosis was seen. A lipiodol injection showed no evidence of bronchiectasis, but a

## Section of Odontology

President—B. MAXWELL STEPHENS, L.D.S.E.

[November 23, 1942]

### DISCUSSION ON THE TREATMENT OF PULPLESS TEETH

Mr. W. Stewart Ross : *The pathology of the dental pulp.*—There are three main tissue reactions as a result of dental caries and infection: (1) The dentinal barrier; (2) the leucocytic barrier in the pulp chamber; and (3) the periapical barrier. All three types are interdependent and represent the normal reaction of the tissues to irritation, but it is of the utmost importance in the treatment of such cases to distinguish the various stages of the bacterial invasion. When the continuity of the enamel is broken by the action of caries, the dentinal tubules become exposed, and the protoplasmic fibrils are irritated. As a result of this, the odontoblast cells situated in the pulp sever their connexion with the primary tubules and commence to lay down secondary dentine. This offers a strong calcific barrier to the advancing caries, and if measures are taken in time to remove the decay and plug the cavity with an efficient seal, the pulp will remain alive and non-infected. Often, however, conservative treatment is delayed, with the result that in the majority of cases, the caries eventually invades the barrier of secondary dentine, the neighbouring odontoblasts are destroyed, and the delicate connective tissue of the pulp becomes exposed to the lesion. Unfortunately inflammatory reaction is usually instrumental in causing the death of the pulp, because the vessels carrying away the inflammatory waste products became occluded at the narrow apical foramen as a result of the swelling and pressure in the pulp. There is, however, an interval between the first invasion of organisms into the pulp chamber and the death of the pulp, which may vary from a day to many months or even years, depending on the size and situation of the cavity and whether the inflammatory exudate can escape through this channel and so reduce the swelling.

If a microscopical section is made of a tooth from a patient who is suffering severe toothache, and the pulp is alive, it will be found that the organisms are situated in the pulp chamber opposite the exposure, *whilst the remainder of the pulp is normal and healthy.* A heavy concentration of leucocytes surrounds the infection, which for the moment is able to localize the condition, and it follows therefore that since the tissues in the pulp canal are not infected, pulp extirpation and root filling can be carried out with consistently successful results. Normal routine procedure, however, appears to neglect the fact that in passing an instrument such as a barbed broach along the root canal, it enters through the infected area in the pulp chamber, and contaminates the rest of the tissues during its passage to the apex. Therefore before any cold instrument is allowed to enter the pulp canal, steps must be taken first to destroy the organisms situated in the pulp chamber.

If no treatment is carried out at this stage, death of the pulp is followed by a rapid spread of infection to the main root canals and accessory canals, and into the periapical tissues. Often the patient is unaware of this second acute inflammation except for a tenderness of the tooth on percussion, but he is conscious of a sudden cessation of the pain which he had experienced when the inflammation was present in the pulp itself.

Although the acute condition may pass away in a short time, the bacteria are not destroyed, because they are able to live in the apical third of the root, where there are numerous accessory canals and permeable secondary cementum in which they can shelter, and a chronic apical condition presents itself, with the organisms ensconced in the apex of the tooth, surrounded by leucocytes which cluster around the opening of each canal into the periapical tissues. Even if the main root canal is sterilized, the organisms still remain in the accessory canals, and it is certain that by the use of strong antiseptic more tissue is destroyed by the drug leaking through the apical foramen, thus presenting those organisms which inevitably escape destruction a further nidus for their growth.

Removal of the apical third of the root which is the nidus for the infection is, as would be expected, an operation usually followed by successful results, and it is unfortunate that this procedure is limited to the single rooted teeth situated in the anterior part of the mouth.



**Hypoproteinæmia of Uncertain Origin.**—F. T. GARNET PRUNTY, M.B., M.R.C.P.

E. W., a male labourer, aged 55, was admitted one year ago complaining of severe swelling of the legs, tiredness and exertional dyspnoea. He had had a similar attack of swelling three years previously which had lasted about five months and disappeared spontaneously. He was subject to attacks of winter bronchitis.

On examination he showed generalized wasting, slight clubbing of the fingers and slurred speech. He had œdema of both legs to the knees and in the sacral region. The liver and spleen were not palpable and there was no clinical ascites. Crepitations were constantly present at the right apex and signs of a moderate degree of progressive muscular atrophy, involving chiefly his hands and forearms, were demonstrated. Blood-pressure was 100/70 and the urine contained no albumin or sugar.

The blood-count was R.B.C. 3,970,000, Hb. 54%, C.I. 0.68, and W.B.C. 8,800 with a normal differential count. X-ray of the chest was clear. The œdema cleared up spontaneously in about two weeks. Plasma proteins were 5.2% with an albumin globulin ratio of 0.8:1. Urea clearance was 76% of maximum clearance, hippuric acid synthesis 107% of normal, Takata-Ara reaction negative, icteric index 3, negative direct Van den Bergh, and no excess urobilinogen in urine nor urinary creatine was found.

Ten months later he was readmitted with a similar attack of œdema. The anæmia was similar with a Hb. of 60%, plasma protein 5.5%, A:G ratio 0.9:1 and plasma fibrinogen 0.55%. The stool was normal and contained only 20% fat. There was achlorhydria to histamine, urea clearance 61% of standard clearance and hippuric acid synthesis 80% of normal. Whilst in hospital he had three attacks of purpura involving mainly the dorsum of his left foot and his legs. Capillary resistance, bleeding time, clotting time and prothrombin time were all normal. There was marked ascorbic acid deficiency, but the third attack of purpura occurred in spite of the exhibition of large doses of this substance.

He was discharged with absent œdema but moderate exertional dyspnoea two months after admission. Blood-count now showed R.B.C. 2,900,000; Hb. 52%; C.I. 0.90. He was treated with large doses of iron and hydrochloric acid with no improvement in the anæmia. During his periods in hospital he received a diet containing 120 g. of protein daily and preparations of all the known vitamins without improvement in the plasma protein, the widest variation in which was from 5.2 to 5.8%. Albuminuria was never present. It was thought possible that deficient protein synthesis in the liver was the most likely cause of his condition.

My thanks are due to Professor O. L. V. de Wesselow for permission to show this case.

of air to the latter. If a course of antiseptic treatment is instituted, therefore, instrumentation should be carried out with caution, little being done at first other than opening the pulp chamber and inserting an antiseptic dressing just within the exposure. If the canal is to be treated and filled at once the root resection should be done within twenty-four hours so as to give no time for acute symptoms to supervene.

Any of the recognized materials are suitable for the root canal filling, a useful one being zinc oxide 90%, zinc sulphate 10%, and eugenol, with a gutta-percha or ivory point as a cone. The mixture may be easily introduced into the canal by means of an engine reamer running backwards, or, in the manner recently suggested, by aspirating the air from the canal by means of a hypodermic syringe. If the apex of the tooth is to be resected within twenty-four hours there is no harm in slightly over-filling the canal in order to ensure a complete seal. When the root canal is filled at the time of operation it is convenient to use a material which will set at once, such as zinc oxyphosphate cement in which is included a little powdered thymol. This can be introduced effectively with a "jiffy" tube only if the canal has previously been very widely reamed.

The operation is most conveniently performed under local anaesthesia. A submucous injection is sometimes effective for a central or lateral incisor, but an interpapillary injection as well usually gives more perfect anaesthesia of the deeper part of the periapical tissues. When dealing with an upper lateral or canine an infra-orbital injection is preferable. The operative details are briefly as follows: The outer plate of bone is exposed by means of a curved incision which crosses the middle third of the root, the convexity of the curve being towards the gum margin. The gum flap is retracted and if the area is of any size a probe may be passed through the outer plate into the cavity, thus defining the position of the apex. Sometimes the outer plate is already completely destroyed in this region. If not, the opening should be enlarged so as to display the apex which may then be cut off with a fissure burr or even destroyed by means of a large rose-head. A large straight excavator is a useful instrument for removing the granuloma and curetting the bone, which may be done either before or after the apex has been removed, according to its position. The wound is then irrigated with saline, inspected to see that all debris has been removed, and allowed to fill with blood. In badly infected areas the cavity in the bone is half filled with sulphonamide powder which is mixed into a paste with the blood. The gum flap is replaced and secured with a stitch which is removed in two days' time.

Post-operative swelling rarely occurs except with large areas and in these sulphonamide powder appears to be beneficial and in no way impairs the healing.

[For illustrations see *British Dental Journal*, 1941, 70, 180-181; and "Operative Dental Surgery", by Parfitt and Herbert, 1939, p. 402, fig. 152.]

**Mr. R. G. Torrens : Replantation.**—In the *British Dental Journal* (Vol. 70), 1941, p. 174, Professor Herbert stated that if root treatment via the canal was unsatisfactory there remained but two alternatives—extraction and root resection. My purpose is to show that there is yet a third method which may be applied to certain types of dead teeth. That method is replantation.

The suitable types are generally those in which root resection is difficult or impossible. The colour of badly stained teeth can be improved; acute abscesses can be treated immediately, provided that infiltration of sepsis is not too great to prevent regional anaesthesia; chronic abscesses can be treated with confidence; recently fractured teeth can be saved by cementing the fragments together with a metal post in the root canal. Premolars and molars can also be treated in this way.

The method is comparatively simple and the percentage of success is high, if certain fundamental surgical principles are observed. A suitable tooth having been chosen, local or regional anaesthesia is carefully obtained. Two pieces of lead foil from an X-ray packet are cut to overlap the tooth under treatment and at least two healthy ones on either side. One of these pieces is burnished to fit closely to the lingual and buccal surfaces of the teeth. The second piece is burnished over the first, so that the outer edge overlaps by about  $\frac{1}{16}$  inch. These are carefully removed, sterilized and dried with a warm air syringe and are then put aside so that they can be replaced in the correct order when required.

The tooth is then carefully extracted to avoid, as much as possible, any damage to the walls of the socket. It is then immersed in hydrogen peroxide (10 vols.) while the toilet of the socket is completed. The next stage is the most important. A review of the literature on the subject of replanting shows that very little stress has been laid on the preparation of the socket, but a great deal on the treatment of the tooth. As the sepsis is for the most part in the depths of the alveolar bone in and about the region

**Mr. Arthur Bulleid:** Though it is now some time since I carried out my original work on the question of the infectivity of pulpless teeth yet nothing has since transpired to alter my opinion that all pulpless teeth are infected teeth and that no technique yet devised can prevent infection in such teeth.

I am convinced that a pulpless tooth must be considered a focus of infection though as I have not carried out many experiments on "apicectomized" upper anterior teeth I cannot say what is the future of such teeth, but from the examinations that I have been able to make I am not too sanguine that they remain sterile.

The radiographic appearance of pulpless teeth cannot be accepted as a criterion of infectivity. The "local" appearance of such teeth does vary and an area of apical osteitis may or may not be present, but as the general resistance to infection varies so much in different individuals it is not possible to state with any degree of certainty that the size of the apical area is a measure of the degree of infection.

Pulpless teeth are all areas of a streptococcal "overload" the danger of which varies in every patient and possibly in any one patient at different periods.

The one point which seems to me important is that no pulpless tooth can be considered innocuous and that if its streptococcal overload can be relieved without undue mutilation to the patient then it is better to extract such a tooth.

**Professor W. E. Herbert:** Mr. Stewart Ross and Mr. Bulleid have already described how easily the periapical tissues become infected as a result of spread of organisms or their toxins from the dental pulp, and the pathological changes which follow. In practice one finds that the majority of those cases which have been established for any length of time are, in fact, apical granulomata and that the area of bone destroyed by them is always at least a third greater than the dark area in the radiograph would lead one to suppose. Some of these granulomata are breaking down in the centre to form an abscess which periodically discharges its contents through a "gum-boil" in the buccal sulcus or drains into the root canal. Once infection is established in the periapical tissues it is not readily amenable to antiseptic treatment within the root canal, partly because antiseptics do not penetrate the tissues easily without causing further damage and partly because a certain amount of dead cementum always remains to provide a nidus for future infection. Occasionally areas are seen to be remarkably reduced in size but rarely to disappear completely. When they do so they are usually of very recent origin and the change is probably that of a simple rarefying osteitis with no involvement of the cementum. In these early cases the best chance of success with antiseptic treatment would seem to be by the use of ionic medication with zinc chloride solution, because this gives the maximum penetration of the zinc ions into the periapical tissues with the minimum of damage. The majority of cases are, however, more effectively treated by means of extraction of the entire tooth and curceting the periapical tissues, or by resection of the apical third of the tooth after treating and filling the root canal.

For a root resection to be performed satisfactorily, the apex must be readily accessible and should not be in close proximity with important structures such as the antrum. The operation is therefore practically limited to the treatment of incisors and canines. It is much easier to carry out if the buccal sulcus is deep so that the lip can be well retracted, and it is particularly indicated in a young patient when a single anterior tooth is involved in an otherwise sound arch, and the area is circumscribed and does not involve more than the apical one-quarter of the root. Opinions differ on the question of preoperative treatment. Some operators advocate a course of antiseptic treatment with drugs such as tricresol, creosote or dettol in order to endeavour to sterilize the dentine before the operation is performed. It is questionable, of course, whether the dentine can be completely sterilized or even whether it is necessary that it should be, so long as the subsequent filling is watertight and the porous part of the root, that is the apical third, removed. Hence others claim that as good results are obtained if the canal is merely reamed, treated at once with strong antiseptics, and filled either the day before operation or at the time of operation immediately after the apex has been removed and the infected area curetted. The latter method is, I feel, better avoided as it is difficult to make a watertight filling at the time of operation and it is also an added complication to have to do it then. The choice of a short course of antiseptic treatment, or of immediate root canal treatment depends rather on the condition of the periapical tissues which is difficult to determine beforehand. If the condition present is a simple apical granuloma, a short course of antiseptic treatment will probably render the canal free from all obvious signs of infection. On the other hand some cases are abscesses draining into the root canal, and others which have been quiescent for a long time will, when treatment is commenced, develop acute or subacute symptoms, whether as a result of disturbance of the balance which has been set up between the tissues and invading organisms or of allowing access

## Section of Surgery

President—E. C. HUGHES, O.B.E., M.Ch.

[November 4, 1942]

### DISCUSSION ON HERNIA

**Major-General C. Max Page:** I propose that the scope of this discussion be limited to a consideration of inguinal hernia. The radical cure of this type of hernia has a considerable bearing on the maintenance of man-power at the present time and I think most surgeons will agree that the evidence on the results of operation throughout the country are somewhat disconcerting. It would appear that in hernia technique two schools of thought compete so far as handling the situation in the healthy adult is concerned. They may be designated that of the hammer and that of harmony. The hammer school says: "Here is a pathological condition of which the surgical cure too often fails: let us therefore in all cases at the first onset do all we can to reinforce the inguinal canal." The method chosen may still be an operation of the Bassini type, or filigree, fascia or floss silk may be fully employed. The harmony group on the other hand gives the normal inguinal sphincter full credit and limits the operation to the removal of the open sac and the repair of any damage which may have been done in the approach.

The follow-up of a large number of hernia cases over a two- or three-year period by personal examination is surprisingly difficult and statistics on the subject are hard to find. In a small localized service such as the Metropolitan Police a closely analysed investigation is possible, and in 1934 Mr. N. R. Barrett examined for me 295 consecutive cases. The results revealed a recurrence rate of over 20% for indirect hernia. Following this investigation the staff of St. Thomas's planned a systematic approach to the problem with a view to obtaining better results, and early this year Mr. A. G. McPherson carried out a careful follow-up of the 174 policemen who had been operated on between 1936 and 1939. The operations had been carried out by many different surgeons, ranging from members of the staff to house-men. Two years were taken as the minimum follow-up period, and of 161 cases of primary hernia traced, 24 or 14.9% recurred. Recurrences in indirect hernia were 12%, in direct hernia 35.3% and in glissade hernia 20%. There were 19 recurrent hernias operated on in this period. All of these were seen or answered the questionnaire. Five recurred, giving a recurrence rate of 26.3%.

It is interesting to compare the results for indirect hernia with N. R. Barrett's series in 1934. In the earlier series the majority of operations were Foster or Bassini repairs and there was only one fascia lata repair (Gallie). In the later series Foster's and Bassini's operations were but rarely performed, simple ligature and excision being carried out if the rings were not unduly stretched and the musculature good. Where repair was considered necessary a fascia lata repair was the usual practice.

The following are the comparative figures:

MR. N. R. BARRETT'S SERIES: INDIRECT INGUINAL HERNIA			
Operation	Number	Recurrences	Recurrence rate
No repair ...	29	4	13.8%
Foster ...	144	31	21.5%
Bassini ...	36	8	22.2%
Other methods ...	4		
Total recurrence = 20.2%			

PRESENT SERIES			
Operation	Number	Recurrences	Recurrence rate
Simple excision ...	86	8	9.3%
Fascia lata repair ...	39	6	15.4%
Other methods ...	17	3	17.6%
Total recurrence = 12.0%			

In the recent series the best results are for the smaller hernias which had ligature and excision only. The fascial repairs which were done for the more unpromising cases had a lower recurrence rate than the operations grouped as "others" which comprised 7 Bassini, 6 Foster, 3 McArthur and 1 Bloodgood.

The figures for hernias other than indirect hernia are small. For direct hernia 17 operations gave a recurrence rate of 35.3% (fascia lata repair, 12 operations with 4 recurrences; Foster's operation, 3 operations with 1 recurrence; Bloodgood's operation, 2 cases with 1 recurrence).

of the apex, it is necessary to remove all carious bone and granulation or infected tissue. This is best done by extensive and careful curetting of the diseased area with a small spoon curette or antrum spoon. The tooth is then removed from the peroxide and any adherent diseased tissue including membrane removed. The root canal is then opened from the apex with suitable drills and enlarged. The apex can be removed if desired. The cavity is also cleansed of decay and a communication made between it and the canal. When thoroughly prepared it is immersed in a fresh peroxide solution (this time half-strength) until all signs of bubbling have ceased. This usually takes a few minutes. When clean it is removed with a sterile forceps and dried with a warm air blast. A medium mix of quick-setting white cement containing a trace of carbolic acid is then worked up the canal from the cavity by means of a spiral reamer used in reverse. When nearly set it can be burnished into place and trimmed to suitable shape. The apex is then trimmed and smoothed with a carborundum stone and the cavity filled with suitable material. If a silicate is used, the varnish must not be forgotten as a further immersion in a fresh solution of weak peroxide is necessary.

The curette, which has been re-sterilized, is used to freshen up the surfaces of the socket, using light pressure this time, and the tooth is dried and placed gently but firmly in the socket and held in position for a few seconds with the fingers. The gums and teeth are now cleaned with alcohol and dried, and a thin sticky mix of cement is spread over each splint. These are placed carefully in position and burnished to obtain closer approximation and are then held firmly until setting is complete.

The splints are easily removed, layer by layer, a week later. If the aseptic routine and surgical procedure have been followed carefully, there should be little or no discomfort and quick healing can be expected. The tooth will be slightly loose upon removal of the splints, but will gradually grow firm and in about four to five weeks it becomes tightly united with the socket. The colour changes in the tooth are very noticeable. At first it looks opaque and dead, yet in a few weeks the shade gradually modifies until it cannot easily be recognized as a dead tooth either by percussion or visual examination.

In records of over fifty cases both in hospital and in private practice it would appear that if the recommended routine has been carefully followed with full surgical procedure the percentage of success is in the region of 90%. If curetting has been insufficient, failure is certain within a short time.

The suitable cases are those in young healthy patients where healing is good and where other methods have proved unsuitable or impossible. It is not suggested that replantation should be employed indiscriminately, but rather that it is a method whereby certain teeth which would otherwise be condemned may be retained for a useful life of several years.

The histology and pathology of such cases I make no attempt to explain. No doubt research into cases of erosion of the root might discover the reason and provide a method of ensuring 100% success. The changes in the socket in satisfactory cases would also be an interesting subject for investigation. The union after a month or so appears normal and there is no macroscopic variation in the gingival margin. Percussion gives no indication of an abnormal union: the X-ray picture shows little or no change in the periosteum. The union of the tooth with the joint, therefore, can only be described as useful until such time as some interested research worker decides to investigate the histo-pathology of the changes.

Results have been observed up to three years, and there is no reason why this period should not indicate a useful life of at least five years in the average case.

## Section of Surgery

President—E. C. HUGHES, O.B.E., M.Ch.

[November 4, 1942]

## DISCUSSION ON HERNIA

Major-General C. Max Page: I propose that the scope of this discussion be limited to a consideration of inguinal hernia. The radical cure of this type of hernia has a considerable bearing on the maintenance of man-power at the present time and I think most surgeons will agree that the evidence on the results of operation throughout the country are somewhat disconcerting. It would appear that in hernia technique two schools of thought compete so far as handling the situation in the healthy adult is concerned. They may be designated that of the hammer and that of harmony. The hammer school says: "Here is a pathological condition of which the surgical cure too often fails: let us therefore in all cases at the first onset do all we can to reinforce the inguinal canal." The method chosen may still be an operation of the Bassini type, or filigree, fascia or floss silk may be fully employed. The harmony group on the other hand gives the normal inguinal sphincter full credit and limits the operation to the removal of the open sac and the repair of any damage which may have been done in the approach.

The follow-up of a large number of hernia cases over a two- or three-year period by personal examination is surprisingly difficult and statistics on the subject are hard to find. In a small localized service such as the Metropolitan Police a closely analysed investigation is possible, and in 1934 Mr. N. R. Barrett examined for me 295 consecutive cases. The results revealed a recurrence rate of over 20% for indirect hernia. Following this investigation the staff of St. Thomas's planned a systematic approach to the problem with a view to obtaining better results, and early this year Mr. A. G. McPherson carried out a careful follow-up of the 174 policemen who had been operated on between 1936 and 1939. The operations had been carried out by many different surgeons, ranging from members of the staff to house-men. Two years were taken as the minimum follow-up period, and of 161 cases of primary hernia traced, 24 or 14.9% recurred. Recurrences in indirect hernia were 12%, in direct hernia 35.3% and in glissade hernia 20%. There were 19 recurrent hernias operated on in this period. All of these were seen or answered the questionnaire. Five recurred, giving a recurrence rate of 26.3%.

It is interesting to compare the results for indirect hernia with N. R. Barrett's series in 1934. In the earlier series the majority of operations were Foster or Bassini repairs and there was only one fascia lata repair (Gallie). In the later series Foster's and Bassini's operations were but rarely performed, simple ligature and excision being carried out if the rings were not unduly stretched and the musculature good. Where repair was considered necessary a fascia lata repair was the usual practice.

The following are the comparative figures:

MR. N. R. BARRETT'S SERIES: INDIRECT INGUINAL HERNIA			
Operation	Number	Recurrences	Recurrence rate
No repair ... ..	29	4	13.8%
Foster ... ..	144	31	21.5%
Bassini ... ..	36	8	22.2%
Other methods ... ..	4		
Total recurrence = 20.2%			

PRESENT SERIES			
Operation	Number	Recurrences	Recurrence rate
Simple excision ... ..	86	8	9.3%
Fascia lata repair ... ..	39	6	15.4%
Other methods ... ..	17	3	17.6%
Total recurrence = 12.0%			

In the recent series the best results are for the smaller hernias which had ligature and excision only. The fascial repairs which were done for the more unpromising cases had a lower recurrence rate than the operations grouped as "others" which comprised 7 Bassini, 6 Foster, 3 McArthur and 1 Bloodgood.

The figures for hernias other than indirect hernia are small. For direct hernia 17 operations gave a recurrence rate of 35.3% (fascia lata repair, 12 operations with 4 recurrences; Foster's operation, 3 operations with 1 recurrence; Bloodgood's operation, 2 cases with 1 recurrence).

of the apex, it is necessary to remove all carious bone and granulation or infected tissue. This is best done by extensive and careful curetting of the diseased area with a small spoon curette or antrum spoon. The tooth is then removed from the peroxide and any adherent diseased tissue including membrane removed. The root canal is then opened from the apex with suitable drills and enlarged. The apex can be removed if desired. The cavity is also cleansed of decay and a communication made between it and the canal. When thoroughly prepared it is immersed in a fresh peroxide solution (this time half-strength) until all signs of bubbling have ceased. This usually takes a few minutes. When clean it is removed with a sterile forceps and dried with a warm air blast. A medium mix of quick-setting white cement containing a trace of carbolic acid is then worked up the canal from the cavity by means of a spiral reamer used in reverse. When nearly set it can be burnished into place and trimmed to suitable shape. The apex is then trimmed and smoothed with a carborundum stone and the cavity filled with suitable material. If a silicate is used, the varnish must not be forgotten as a further immersion in a fresh solution of weak peroxide is necessary.

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scrotal hernias in pot-bellied subjects of poor physique. (c) Large recurrent hernias in men of low category. (d) Large hernias in men of low category on account of other diseases, e.g. severe flat foot.

(2) *Surgical technique.*—Bassini or one of its modifications is still the most popular operation (60% of a series of 147 cases). Most of the operations for recurrence follow the Bassini operation though none is immune. I have no doubt, both from analysing such figures as I have and also from recent fairly extensive experience of operations upon recurrent hernias, that recurrence is actually and relatively more common after the Bassini operation than any other, and for this reason I think the operation should be abandoned.

(3) *Analysis of operations upon recurrent hernias.*—In a period of fifteen months 88 operations were performed by myself and Lt.-Col. Capper at a military hospital, and records of findings made. The following facts emerged: (1) 75% of the recurrences were indirect, i.e. the original hernia was reproduced. (2) 63.7% (nearly two-thirds) recurred during the first twelve months. 22.1% recurred during the second year. 14.2% recurred after the second year. (3) Of the 22 direct, 12 were diffuse bulges and 10 were funicular sacs coming through a well-defined opening in the transversalis fascia. None followed Bloodgood's operation or anterior reposition of the cord. (4) 55 followed a primary Bassini operation. The actual findings were either that the stitches between the conjoined tendon and Poupart's ligament had pulled out, or that the muscle fibres medial to the internal ring were converted into a sheet of fibrous tissue.

### CONCLUSIONS

The fact that most recurrences are indirect hernias—reproductions of the original—shows that the weak spot is at the site of ligation of the sac. Some of them were doubtless due to failure to find the sac originally, or to inefficient ligation of the neck. In three cases scarring was present at the neck of the sac, indicating that the recurrent sac was an adventitious one. In several cases scarring was found at the fundus, indicating that the peritoneal sac was an entirely new one. Such a sac can develop more quickly than is generally supposed. I have operated on cases which have developed such a sac within twelve months after the first operation. It is widely recognized that the sac should be completely excised, flush with the peritoneal cavity. It is not so widely recognized, however, that the first line of defence is the transversalis fascia deep to the internal ring. To my mind the repair of this is an essential part of the operation. The fascia should be dissected free of the peritoneum. A ragged defect remains, more clearly defined above and to the outer side of the ring than elsewhere. The defect should be closed with Chinese silk or chromicized catgut by U-sutures which pass through Poupart's ligament. Alternatively, a slip of fascia from the upper leaf of the divided external oblique aponeurosis may be used.

Nothing need be done to reinforce the posterior wall of the inguinal canal medial to the internal ring, if the muscles are good, the sac clearly defined, and the internal ring not unduly stretched. My reasons for this conclusion are: (1) Most of the recurrences are indirect, and repair of the posterior wall can have no effect in stopping them. (2) Many of the direct recurrences are due to disturbing the cord from its bed, and attempting to reinforce an area which cannot be held in any way responsible for the original herniation.

My contention is therefore that in the young muscular subject the best operation we can offer is complete excision of the sac with repair of the transversalis fascia, without disturbing the cord in its bed, and I would make a plea for the general adoption of this operation.

When the internal ring has been considerably stretched by a large scrotal hernia in older subjects the position is not so clear, and in addition to the above steps, some reinforcement will be necessary to the posterior wall. I think this best achieved by turning down a flap of the anterior sheath of the rectus (Bloodgood's operation) or by the use of the fascia lata. A further strengthening may be obtained by anterior reposition of the cord, in front of the resutured external oblique. The amount of fascia obtainable from the cut edge of the external oblique is insufficient to make a thoroughly reliable repair.

For direct hernias, repair of the defect will always be needed, and here a local fascial flap, or, perhaps better, fascia lata, will be required. I would briefly draw attention to that funicular type of direct hernia described by Ogilvie and later by Gill. It can easily be missed unless the operator is mindful of the possibility. A curious feature of my own records is that this type of hernia was found only twice in 331 first-time operations, but ten times in 88 recurrent cases. I have no adequate explanation to offer for this.

*Use of floss silk.*—During a period of twelve months, Lt.-Col. Capper and I have used floss silk in 219 consecutive first-time hernia operations, doing what we thought to be a thorough repair of the whole canal, both medial and lateral to the cord. We were pleased with



For glissade hernia 4 operations gave 25% recurrences (fascia lata repair, 3 operations and no recurrences; external oblique overlap, 1 operation with recurrence), and for recurrent hernia 19 operations gave 5 recurrences, all following fascia lata repair, which was done in 18 cases.

With regard to type of recurrence, it should be noted that all the patients seen with recurrence were doing full duty as policemen, the majority of recurrences were small and in 6 cases were unrecognized by the patient. Recurrences were classified as follows: Indirect 7, Direct 5, Incisional 1, Interstitial 1, Undetermined 10.

The interval between operation and recurrence is shown in the following table:

Interval	Primary hernia	Recurrent hernia
First 6 months	7	3
6-12 months...	1	1
1-2 years	2	1
2-3 years	6	
3-4 years	2	
Noted only at follow-up	6	

Recurrences are most commonly noted in the first six months, but many occur later.

*Comment.*—The results demonstrated were frankly disappointing, but may be accepted as accurate; every recurrence or suspected recurrence was examined by myself and Mr. McPherson. It will be noted that in both series the lowest recurrence rate is found after a simple herniotomy operation. In my opinion such an operation is that of choice in oblique hernias in healthy young men. I would define "young men" for this purpose as those between 18 and 35.

I have confined my opening remarks mainly to the subject of primary indirect hernia because it is clearly of the first importance, both now and in the immediate future.

**Brigadier Harold Edwards:** The problem of the inguinal hernia is not a new one but it has become more insistent to-day because of the extensive invalidism hernia is causing among our fighting men. I do not know the percentage incidence of the condition, but I can furnish figures which give some indication of its frequency. Thus: (a) In one military hospital 419 operations for hernia were done during a period of fifteen months. (b) At two convalescent depots visited a little time ago 125 out of 950 patients (13.2%) and 72 out of 750 patients (9.6%) were hernia cases. (c) Of a recent intake of 1,300 new recruits of the 35-36 age-group, 143 had hernias. Recurrence after operation is very common: thus in the six months January to June, 1942, 805 operations were performed for recurrent hernia in military hospitals. This does not represent more than 60% of all recurrences seen, for operation is frequently refused. At one centre for example, of over 140 recurrences seen only 100 were operated upon. From incomplete figures from many sources. I estimate the recurrence rate to be at least 12%. I know that I am open to criticism in this estimation because I have no exact figures. Most of the cases, by far, were operated upon in the late teens and early twenties. Many of the older men had been operated upon a long time before they were called up. In these the hernia had recurred as a rule within two years of operation, and had been down for many years before they enlisted. They could manage to do their civilian work, with or without a truss, but could not stand the strain of Army life.

The causes of recurrence are many: Unsuitable selection of cases; indifferent surgery—missing the sac altogether, for example, or failure to secure hæmostasis; sepsis: serious chest complications, &c. The biggest single factor is undoubtedly the actual technique of the operation, and I feel that it is up to us to inquire which of the many operations now performed is the best. But the matter does not stop there. We must also concern ourselves with the question of rehabilitation. How are we going to get the soldier fit again as a fighting man in the minimum possible time after operation?

The operation for hernia is not an easy one, and certainly should not be regarded as a first exercise for the embryo surgeon. It should be performed only by surgeons of reasonable experience. With this recommendation every surgeon of standing (with whom I have discussed the point) agrees whole-heartedly: but though there is such unanimity of opinion nothing whatever is being done about it as far as I can see. No one is allowed to violate the sanctity of the knee-joint unless he be an orthopædic surgeon or an experienced general surgeon, but as far as invalidism is concerned in the Army, hernia is numerically a greater problem than the knee: and further, a large recurrent hernia may be as great a handicap to the individual throughout life as a troublesome knee-joint. I am not advocating that herniotomy should be a new speciality, but I do think that as far as is possible hernia patients should be sent to the larger hospitals where skilled surgeons are available and where, in addition, facilities exist for organized rehabilitation.

I will briefly particularize on three aspects:

(1) *Selection of cases—the Army standpoint.*—The following types of cases should not be operated upon: (a) The small bulge in men of inferior musculature. (b) Large

scrotal hernias in pot-bellied subjects of poor physique. (c) Large recurrent hernias in men of low category. (d) Large hernias in men of low category on account of other diseases, e.g. severe flat foot.

(2) *Surgical technique*.—Bassini or one of its modifications is still the most popular operation (60% of a series of 147 cases). Most of the operations for recurrence follow the Bassini operation though none is immune. I have no doubt, both from analysing such figures as I have and also from recent fairly extensive experience of operations upon recurrent hernias, that recurrence is actually and relatively more common after the Bassini operation than any other, and for this reason I think the operation should be abandoned.

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the results, for the cases were followed through until they were discharged fit for full duty, having passed the final test at the convalescent depots, and none recurred. Then the bogey of sepsis appeared, and in five later cases, removal of the floss silk was necessary—no easy matter. Since that time I have seen a number of cases done at other hospitals who suffered a similar fate, and other surgeons have had a similar experience. For this reason I have, somewhat reluctantly, come to the conclusion that the use of floss silk as a routine should be discontinued.

**Rehabilitation.**—I make no claim that special exercises will reduce the recurrence rate, but I know them to be a factor in hastening the return of a soldier to full duty. I have compared the physical and mental condition of patients who have been through a prescribed regime and those who have been neglected from this standpoint. Whatever theoretical grounds there be against the early practice of abdominal exercises, the value of the exercises is sufficiently established to warrant their routine adoption. The routine now practised in some of the larger military hospitals is as follows: Three weeks in bed; exercises commenced on the twelfth day; three to four weeks in suitable B.R.C.S. auxiliary hospitals where exercises are continued under instruction; four weeks in a convalescent depot, at the end of which the patient is able to carry out full duties as a fighting man. The average time between operation and return to depot is twelve weeks.

**Major J. C. F. Lloyd Williamson** advocated the use of a fascial graft from the thigh in all males over the age of 17. He reached this conclusion from the study of a series of 142 cases of hernia in adult males, of which 18 treated by removal of a sac gave a recurrence rate of only 22%; in 25 an external oblique graft was used with recurrence in 4%, while in 20 cases of direct hernia in which a thigh graft was used 5% recurred and in 99 cases of indirect hernia similarly treated only 1% recurred. Over 90% were followed up for 3 years or more. A certain number of the thigh-graft cases have occasional pain, cramp, stitch, irritation or a feeling of weakness in the thigh, but the use of a fasciatome in place of the open operation with the long scar has greatly diminished the incidence, and in nearly every case any discomfort has disappeared or become insignificant in two or three months from operation. A course of abdominal and thigh exercises before and after operation was of value.

**Major G. E. Parker** emphasized the importance of total removal of the hernial sac. He felt that, in cases where the hernia was direct—or if there was a direct “bulge” associated with an oblique hernia—the stripping of the sac should be carried medially until the muscular fibres of the bladder appeared in the wound. There was then no danger of injury to the bladder, and complete removal of the sac and the direct bulge were ensured.

Major Parker favoured the use of floss silk both for repair by apposition and for darning technique in hernia operations.

**Wing Commander A. W. Badenoch** said that at his R.A.F. hospital 83% of the cases of inguinal hernia were treated by McArthur's operation, but he was unable to give the figures for recurrence rate as no follow-up had been attempted.

**Mr. A. Dickson Wright** felt that if silk was used in hernia operations it should be used exclusively. The mixing of silk and catgut was more likely to lead to sinus formation than silk alone, which in his experience had been most satisfactory.

The external oblique was a most important barrier to hernia and he felt that if the external oblique was slit along the whole length of the inguinal canal a hernia would result in spite of the inguinal shutter mechanism. The artificial hernias produced in Poland in pre-1914 days were produced by this method. He therefore felt that the closure of the external oblique was very important and the suturing of the upper leaf was made to Poupart's ligament and the cord brought up in a gentle arc in front of this leaf and fixed with a few silk points. The lower leaf was now brought over the upper leaf and stitched in double-breasted fashion. He regarded this firm suturing of the aponeurosis and the upward direction of the cord as vital preventives of recurrence.

**Mr. Kenneth Heritage** described an operation which had been used by him for the last four years in all cases of direct hernia or direct weakness. Patients had been followed-up, and so far one recurrence of the indirect type in a man with chronic pulmonary disease had been seen. He maintained that with direct hernia the conjoined tendon had lost its insertion to the ileo-pectineal line and if the condition were bilateral even the pubic insertion was stretched and ineffective.

The operation was as follows: With the patient in half-Trendelenburg position with slight flexion of the head and foot of the table, the abdominal wall is relaxed. The hernia is lifted up with a curved spatula and the attachment of the transversalis fascia to Poupart's ligament is separated by blunt dissection exposing as much as possible of Cooper's ligament.

With a No. 5 Mayo needle four or five interrupted stout linen thread sutures are inserted into Cooper's ligament. Both ends of each suture are now reefed through the anterior surface of the conjoined tendon and transversalis fascia, so that when tied down and back the hernia is reduced and the conjoined tendon and transversalis fascia are carried down into the pelvis. When a large neck is present it is commonly unnecessary to open the hernial sac and difficulties of dealing with sliding herniæ of the colon or bladder are obviated. These sutures have carried the relaxed conjoined tendon back to Cooper's ligament rather than down to Poupart's ligament and so deepen the inguinal canal. Further relaxation can be obtained by incising the anterior rectus sheath. After tying, the same sutures are used to pick up the upper edge of Poupart's ligament and bring it up in front of the conjoined tendon.

This three-point fixation secures the conjoined tendon between Cooper's ligament and Poupart's ligament. After repair of the area of the internal ring with linen thread, the external oblique aponeurosis is easily closed in overlap owing to the increased depth of the inguinal canal. An efficiently contracting conjoined tendon produces a triangular depression above each external ring and attempts to produce this serve as useful post-operative exercises.

It is claimed that by this method the normal anatomy is restored in a somewhat exaggerated form and that by reinsertion the conjoined tendon gains bony fixation for the lower abdominal wall.

**Cinematograph Demonstration:** A coloured film illustrating "Filigree operation for inguinal hernia" was shown by Mr. Percival P. Cole, F.R.C.S.

[December 2, 1942]

## DISCUSSION ON VARICOSE VEINS

**Mr. Reginald T. Payne:** Varicose veins may be defined as "permanent dilatations of the superficial veins of the lower limbs with valvular insufficiency and a potential or actual reverse or to and fro movement of the blood, usually accompanied by tortuosity of the veins, with or without thinning of the vein walls". This paper deals chiefly with the treatment of primary or idiopathic varicosities, and the secondary varicosities occurring in deep thrombosis are discussed only briefly.

Primary varicosities are extremely common in all classes of the community.

**Ætiology.**—Primary varicosity is about three times as common in women as in men. A family history of the disease was present in two-thirds of my cases. The highest incidence of onset occurred at 20 years of age in males and 25 in females. In women the disease tends to develop at periods of endocrine stress; a small number start at puberty, the peak occurs during the early years of childbearing, and a much smaller peak at the time of the menopause.

**Physiology.**—The physiology of the varicose circulation has been established by many methods. The valvular insufficiency leads to a reversal of the flow of blood in the saphenous system when the limb is in the vertical or almost vertical position. The superficial circulation thus partakes of a to and fro movement which is determined by posture. Many of the complications are due to the altered condition of the blood resulting from stagnation.

### CLASSIFICATION

The various types of varicose veins can be classified as follows: (1) Typical varicosity of one or more of the anatomical groups. (2) Isolated, tortuous veins, not involving the main saphenous veins. (3) Diffuse varicosities, sponge-like in character, and usually including both saphenous systems. (4) Ectasia, a condition in which there is dilatation and increase in size of the veins associated with valvular incompetence but with the veins remaining relatively straight and thick-walled. (5) Any of the above groups associated with localized saphenous or other varices. (6) Varicules or telangiectases.

**Diagnosis.**—Accurate treatment can only be based on accurate diagnosis which must include the ætiological data, the anatomical and pathological findings and the tests of valvular incompetence.

**The disease.**—Varicose diseases must be regarded as dynamic and not static. The dynamic factor is partly an inherent weakness in the venous system and partly the mechanical factor which tends to the spread of the disease from varicose to non-varicose vessels. The natural history and course of the disease in the individual patient has, therefore, important bearings upon individual treatment.

**Treatment.**—Three essentials must be borne in mind in discussing treatment. Firstly,

the results, for the cases were followed through until they were discharged fit for full duty, having passed the final test at the convalescent depots, and none recurred. Then the bogey of sepsis appeared, and in five later cases, removal of the floss silk was necessary—no easy matter. Since that time I have seen a number of cases done at other hospitals who suffered a similar fate, and other surgeons have had a similar experience. For this reason I have, somewhat reluctantly, come to the conclusion that the use of floss silk as a routine should be discontinued.

*Rehabilitation.*—I make no claim that special exercises will reduce the recurrence rate, but I know them to be a factor in hastening the return of a soldier to full duty. I have compared the physical and mental condition of patients who have been through a prescribed regime and those who have been neglected from this standpoint. Whatever theoretical grounds there be against the early practice of abdominal exercises, the value of the exercises is sufficiently established to warrant their routine adoption. The routine now practised in some of the larger military hospitals is as follows: Three weeks in bed; exercises commenced on the twelfth day; three to four weeks in suitable B.R.C.S. auxiliary hospitals where exercises are continued under instruction; four weeks in a convalescent depot, at the end of which the patient is able to carry out full duties as a fighting man. The average time between operation and return to depot is twelve weeks.

Major J. C. F. Lloyd Williamson advocated the use of a fascial graft from the thigh in all males over the age of 17. He reached this conclusion from the study of a series of 142 cases of hernia in adult males, of which 18 treated by removal of a sac gave a recurrence rate of only 22%; in 25 an external oblique graft was used with recurrence in 4%, while in 20 cases of direct hernia in which a thigh graft was used 5% recurred and in 99 cases of indirect hernia similarly treated only 1% recurred. Over 90% were followed up for 3 years or more. A certain number of the thigh-graft cases have occasional pain, cramp, stitch, irritation or a feeling of weakness in the thigh, but the use of a fasciatome in place of the open operation with the long scar has greatly diminished the incidence, and in nearly every case any discomfort has disappeared or become insignificant in two or three months from operation. A course of abdominal and thigh exercises before and after operation was of value.

Major G. E. Parker emphasized the importance of total removal of the hernial sac. He felt that, in cases where the hernia was direct—or if there was a direct “bulge” associated with an oblique hernia—the stripping of the sac should be carried medially until the muscular fibres of the bladder appeared in the wound. There was then no danger of injury to the bladder, and complete removal of the sac and the direct bulge were ensured.

Major Parker favoured the use of floss silk both for repair by apposition and for darning technique in hernia operations.

Wing Commander A. W. Badenoch said that at his R.A.F. hospital 83% of the cases of inguinal hernia were treated by McArthur's operation, but he was unable to give the figures for recurrence rate as no follow-up had been attempted.

Mr. A. Dickson Wright felt that if silk was used in hernia operations it should be used exclusively. The mixing of silk and catgut was more likely to lead to sinus formation than silk alone, which in his experience had been most satisfactory.

The external oblique was a most important barrier to hernia and he felt that if the external oblique was slit along the whole length of the inguinal canal a hernia would result in spite of the inguinal shutter mechanism. The artificial hernias produced in Poland in pre-1914 days were produced by this method. He therefore felt that the closure of the external oblique was very important and the suturing of the upper leaf was made to Poupart's ligament and the cord brought up in a gentle arc in front of this leaf and fixed with a few silk points. The lower leaf was now brought over the upper leaf and stitched in double-breasted fashion. He regarded this firm suturing of the aponeurosis and the upward direction of the cord as vital preventives of recurrence.

Mr. Kenneth Heritage described an operation which had been used by him for the last four years in all cases of direct hernia or direct weakness. Patients had been followed-up, and so far one recurrence of the indirect type in a man with chronic pulmonary disease had been seen. He maintained that with direct hernia the conjoined tendon had lost its insertion to the ileo-pectineal line and if the condition were bilateral even the pubic insertion was stretched and ineffective.

The operation was as follows: With the patient in half-Trendelenburg position with slight flexion of the head and foot of the table, the abdominal wall is relaxed. The hernia is lifted up with a curved spatula and the attachment of the transversalis fascia to Poupart's ligament is separated by blunt dissection exposing as much as possible of Cooper's ligament.

are changed at intervals of one or two weeks and at each change the veins are injected. Operative treatment must be carried out whenever it is indicated. Small and recent ulcers usually heal during the period of bed. Large ulcers are best treated with an initial period of bed in order to get healing before the operation is performed, and finally with elastoplast during convalescence. If the underlying bone is involved, scraping and skin grafting may be necessary. When ulceration is associated with diffuse phlebitis of sock type, prolonged elastoplast treatment is essential, and later operative treatment may be necessary. There have been three cases of malignant disease superimposed upon varicose ulceration in my series, and for this complication amputation is required.

**Phlebitis.**—Phlebitis is a common complication of varicose diseases. In the majority of cases this is a bland thrombus in a dilated vessel with poor nourishment of the intima and stasis of the contained blood. Such cases must be differentiated from thrombophlebitis migrans and bacterial thrombophlebitis. Bland thrombi occur in approximately 15% of patients with varicose veins. Pulmonary emboli are rare. Patients should not be given injections for at least six months after the subsidence of the phlebitis. If injections are given earlier, their massive thrombosis is likely to occur, and some, at least, of the published fatal pulmonary emboli have occurred when phlebitic patients have been injected.

Milder cases usually resolve with ambulant elastoplast treatment. The more extensive cases should be treated in elastoplast but confined to bed. Cases of sock phlebitis with induration of the tissues and a line of demarcation in the calf between healthy and unhealthy tissues must be treated by elastoplast for from four to six months. At a later stage injections or operation may be needed. Operative treatment is indicated when there is massive thrombosis in huge tortuous vessels, and this will shorten convalescence by many months; in cases of chronic or recurrent phlebitis which do not respond to other measures; in thrombophlebitis associated with bacterial infection; and finally as a form of radical treatment in patients who have had an antecedent sock phlebitis.

**Pregnancy.**—When varicose veins start or progress during pregnancy, they invariably do so about the second or third month, that is, at a time when uterine pressure is unlikely to be a factor. Owing to the rapidity of development, the association with pregnancy and the certainty of marked regression at term, active treatment is rarely required. The more severe cases should be treated by means of stockings or supports. Injection treatment should be reserved for those cases where the veins are very large or when there are marked symptoms at an early stage of pregnancy, but quinine preparations must be avoided. A patient who has had serious trouble with varicosities during pregnancy should not proceed to a further pregnancy until treatment has been carried out, owing to the likelihood of further disability and the increased risks of phlebitis and deep thrombosis.

**Deep thrombosis.**—Deep or femoral thrombosis may occur as a sequel of pregnancy, operations, specific fevers, pulmonary infections, trauma, &c. The pathological features of the condition are still far from being exactly determined, but it is probably a combined lymphatic-venous obstruction. In a series of 85 cases which I reported in the *Lancet*, 1938, (i) p. 1214, there was no case in which the limb returned entirely to normal. A proportion of cases develop secondary varicosities, either in the saphenous veins or in lower abdominal veins, or in both. It is essential to recognize this group of patients with secondary varicosities not only from the point of view of the history, but also from the presence of abdominal varicosities or an œdematous limb. Most patients are left with a limb which is heavy, swells after a few hours' activity, and is prone to phlebitis, eczema, and ulceration. The general treatment cannot be discussed here. A few of these patients can be helped either by injections or by means of a combination of operation and injections. Firstly, no case should be operated on or injected till many years have elapsed after the thrombosis. Secondly, only those cases are likely to benefit from treatment when varicosities are present and there is little or no œdema. These compensatory varicosities result from obstruction of deeper veins. But recanalization of deep veins may occur, and with time the superficial veins may become incompetent and an embarrassment to the venous circulation. Active treatment may then relieve symptoms and cure complications. In cases of this type I have obliterated limb varicosities by means of injections or combined operation and injections, and I have also obliterated abdominal veins which threatened by the thinning of the overlying skin to rupture. With a strict selection of cases I have never seen other than good results, especially in the cure of eczema, ulceration, and phlebitis, and the prevention of further similar complications.

**Mr. Harold Dodd:** There are three aspects of the operative treatment for varicose veins: (1) The diagnosis of the types of varicose veins in the leg; (2) the details of the operation of simultaneous ligature and injection, and (3) the complications and causes of indifferent results.

the natural history of the disease in the individual patient; secondly, the limb circulation must be considered as a whole; thirdly, in complicated cases the question of infection, skin changes and scarring of subcutaneous tissue, bone, &c., must also be considered. Fundamentally it must be recognized that existing varices can be eradicated but the underlying "soil" cannot be altered.

(For discussion on the aim of treatment, see *British Medical Journal*, October 18, 1941 (ii), 533.)

#### TREATMENT OF UNCOMPLICATED CASES

*Injection treatment.*—The response is excellent in relatively thin-walled and tortuous veins, and with careful technique complications are extremely rare. My personal preference is for quinine-urethane solution on account of the certainty of its action, the rarity and mildness of toxic symptoms, its standard composition and the ease with which it can be sterilized. Injections are most effective when given into the collapsed vein with the patient lying down, after the needle has been introduced whilst the veins are distended by a temporary rubber tourniquet. Recanalization is most likely to occur in calf veins when an incompetent saphenous vein in the thigh has been overlooked, or in cases of ectasia, and it will certainly take place when only a few of the veins have been thrombosed.

*Combined treatment.*—Combined operative and injection treatment is specially indicated in cases with incompetence of the saphenous vein in the thigh, in those with one or more large saccular varices, in cases of ectasia, in veins of large size, and also in cases where injections have either failed or given only temporary thrombosis. The relative indications for combined treatment are the rapidity of the development of the veins, an early age onset, a bad family history, the presence of congestion or complications, the possibility of subsequent pregnancies, and work which involves much standing. The various methods which have been used include ligation at the sapheno-femoral junction with immediate injection of the distal veins; multiple ligations of the main veins; and, more recently, multiple subcutaneous ligations. My own preference is for an operation which combines multiple ligations of the saphenous vein in the thigh with two or more ligations and excisions of large vessels in the calf. The technique of this was described in the *British Medical Journal*, 1941 (ii), 533. The veins are marked in previous to operation, the operative field is treated with the greatest aseptic precautions, and patients are kept in bed for fourteen days. Cases are reviewed a fortnight later and any remaining veins are injected. Finally, all cases are reviewed at intervals of a year.

#### TREATMENT OF COMPLICATED CASES

The treatment of complicated cases includes all those with eczema; skin infection; ulceration; scarring of skin, subcutaneous tissue and muscles; bone involvement; secondary deformity, such as talipes equinus; lymphatic obstruction; and all types of phlebitis. Effective treatment must deal not only with the actual complication but also with the underlying and causative varicosities. In all cases a programme of individual treatment is necessary.

*Varicose eczema.*—Varicose eczema may arise in any of the following ways: (1) Secondary to congestion around the lower part of the shin or malleoli. (2) Directly over varicosities. (3) Around a varicose ulcer. (4) In association with deep thrombosis. (5) As part of a generalized eczematous tendency and therefore not strictly varicose in origin.

Cases must be separated into a group in which the veins are suitable for injection treatment and a group suitable for combined treatment. When injections are indicated they may be started at once if the skin changes are slight. When the skin changes are advanced or extensive, local applications in the form of calamine or zinc ointment, X-rays, or an initial period of bed, must precede treatment. When combined treatment is indicated the programme must be based on this. If the eczema is slight, operation can be proceeded with at once. When the eczema is extensive, operative treatment should be deferred until local applications, X-ray treatment or rest in bed have relieved the skin condition. In the worst cases the operation may be done in two stages: firstly, all veins are dealt with which can be approached through healthy skin, then the eczema is treated, and finally at a subsequent operation all remaining veins are dealt with.

*Ulceration.*—The response of ulceration to treatment depends upon its duration, extent, the degree of local scarring, and the presence of phlebitis or lymphatic obstruction. The prognosis is good in small ulcers with healthy surroundings, and poor in large, long-standing ulcers with induration of the tissues and underlying periostitis. Treatment must be based on the appropriate treatment of the underlying veins. In addition to injection or operative treatment it may include bed, local applications, and supporting bandage. If injections are indicated, they should be combined with the use of elastoplast bandages. The bandages

are changed at intervals of one or two weeks and at each change the veins are injected. Operative treatment must be carried out whenever it is indicated. Small and recent ulcers usually heal during the period of bed. Large ulcers are best treated with an initial period of bed in order to get healing before the operation is performed, and finally with elastoplast during convalescence. If the underlying bone is involved, scraping and skin grafting may be necessary. When ulceration is associated with diffuse phlebitis of sock type, prolonged elastoplast treatment is essential, and later operative treatment may be necessary. There have been three cases of malignant disease superimposed upon varicose ulceration in my series, and for this complication amputation is required.

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It is important to differentiate between varicose veins and compensatory veins: the latter result from the obliteration of the deep venous channels (i.e. the vena comites of the anterior and posterior tibial arteries, thrombosis of the femoral vein or less often, of the external iliac veins) because usually these compensatory veins require but conservative surgical treatment. Varicose veins are veins which have lost their elasticity, and as a result have become dilated, elongated, tortuous and pouched, their valves incompetent and their walls fibrosed and thickened, the deep channels are usually clear.

Where there is no apparent cause for varicose veins such as a familial weakness, pregnancy or long-standing arduous work, the predisposing effect of a toxic focus, e.g. tonsils and septic teeth, should be considered. Sufficient instances have been seen to convince me of the connexion, particularly in varicosities in otherwise fit young people.

*The diagnosis of compensatory enlarged veins in the legs, secondary to obliterated deep veins.*—(1) The history of white leg after pregnancy, typhoid fever, peritonitis, &c., and also after fractures and injuries to the lower limb. (2) Such patients complain particularly of the weight, weakness and weariness of the part which is swollen, white and of wooden non-pitting hardness. (3) In some instances, the shape of the calf is cylindrical; it can be described as an elephant leg. (4) The swelling may obscure the enlarged veins; dermatitis, eczema or ulceration may be present. (5) The tourniquet test for obliterated deep veins is the most dependable. A well-padded tourniquet is placed tightly round the middle of the thigh and the patient is sent for a walk, usually round the out-patient hall. If the deep veins are patent, this exercise is easily accomplished, but if the deep veins are obliterated, then the superficial veins being obstructed by the tourniquet become engorged, causing intense pain and cyanosis of the leg, and the patient returns unable to complete the exercise and asking for the tourniquet to be removed. Such veins are truly compensatory, and generally speaking, surgical treatment is contra-indicated.

#### THE DIAGNOSIS OF VARIETIES OF VARICOSE VEINS

My experience teaches that for adequate treatment an accurate diagnosis of the type of varicose vein is essential: (1) Incompetent internal saphenous vein, uni- or bilateral; (2) incompetent external saphenous vein, uni- or bilateral; (3) incompetent internal and external saphenous veins together; (4) incompetent communicating veins, thigh or leg or both; (5) incompetent communicating veins, plus No. 1; (6) incompetent communicating veins, plus No. 2; (7) incompetent communicating veins, plus No. 3.

The variability of veins and the frequent communications between the long and short saphenous groups must be kept in mind. Again, veins in the lower third of the back of the thigh can be filled from an incompetent external saphenous vein below.

The following tests are carried out:

*The cough impulse.*—Patients are inspected when standing exposed to above the pubis. A hand is placed over the enlarged vessel first above and then below the knee, and on the patient coughing, an impulse, possibly a thrill, is detected by the fingers. The cough impulse test is not so delicate as the Trendelenburg, which is made next.

*The Trendelenburg test.*—For this test I find two tourniquets are necessary. When testing the internal saphenous veins one is placed around the upper thigh, the other just below the knee. They are put on tight enough to obliterate the veins and before doing so the veins are carefully emptied by the patient lying down, the leg raised and the vessels stroked towards the heart. On the patient standing, the lower tourniquet is taken off and the enlarged veins closely watched. Then the upper one is removed, the veins in the leg being watched meanwhile and not the tourniquet. It needs some experience to interpret the results. Anything from a slow down-creeping stream to a heaving cascade may occur. If the enlarged veins are only in the leg, then they can be filled either by the internal or by the external saphenous vein. If by the latter, then the veins fill on removal of the lower band, but if not, and then if the internal saphenous is incompetent, the filling will take place on loosening the upper band. Incompetence of the internal saphenous vein is indicated by a positive Trendelenburg test, usually a cough impulse and perhaps a saphena varix.

*Incompetence of the external saphenous vein* is present often, although so far in my series it is considerably less frequent than that of the internal saphenous. The cough impulse is rarely present over its termination. An anatomical review is apposite. The external or short saphenous vein ends by joining the popliteal vein at or above the crease behind the knee in the middle line. It lies deeply between the two heads of gastrocnemius. Like other veins it is fairly variable. It pierces the deep fascia 2 to 3 in. below the fold of the knee and lies between the gastrocnemius overlaid by fat, so that it is not palpable or visible, and is thereby often missed or unconsidered.

It may be duplicated, triplicated or quadrupled, the parts lying side by side or overlying

each other. The main trunk may lie intramuscularly and to locate it, it is necessary to expose the popliteal vein and expose the junction of the two. Lying amongst the branches are occasionally branches of the internal popliteal nerve and these must be defined and avoided. Then there are branches joining it from above, and these must be recognized and tied off, usually it is only one. The ligature and injection of this vein can be a major surgical exercise.

In recent years the need to test for its incompetence by the two tourniquets has been realized. They are placed round the elevated limb, one on the lower thigh and the other below the knee. The lower constriction is released and when the external or short saphenous vein is incompetent, the down-filling impulse is seen. The internal saphenous vein is controlled by the upper band during this test.

*Simultaneous incompetence of the internal and the external saphenous veins* is tested for by repeating the tests just described. Should the enlarged veins be mainly in the leg and not in the thigh, then when the internal saphenous vein is being tested, the external saphenous vein must be controlled by the pressure of the fingers, a somewhat difficult exercise. Experience is showing the frequency of the double incompetence and cases of partial success after ligature of the internal saphenous are returning.

*Incompetent communicating veins.*—Incompetent communicating veins are diagnosed when the varicose veins have been emptied, the two tourniquets placed round the thigh and below the knee, and on the patient standing, the varices in the thigh or the leg or both reappear within thirty seconds. This is an arbitrary period and the speed of filling assists in deciding the treatment, whether by operation or by injection. Purely incompetent communicating veins in my series are rare. They are mostly associated with some degree of incompetence of either the internal or the external saphenous vein.

By variation of the position and closeness of the tourniquets the precise location of the incompetent vein can be estimated. The full diagnosis of a patient's varicose veins may take a quarter of an hour or twenty minutes, but it leads to precision and effectiveness in treatment. The diagnosis is almost as intriguing as a nerve condition.

The further diagnoses are determined by the tourniquet tests. They are: Incompetence of the internal saphenous veins plus incompetence of the communicating veins in the thigh or the leg, incompetence of the short saphenous vein and communicating veins, and lastly incompetence of the internal and external saphenous veins plus incompetent communicating veins.

#### THE TREATMENT OF VARICOSE VEINS BY THE OPERATION OF SIMULTANEOUS LIGATURE AND INJECTION

Follow-ups show this to be a most useful operation. It needs great care or it is costly and incapacitating and brings the procedure into disrepute.

*The anæsthetic.*—All anæsthetics are satisfactory; personally I prefer a local infiltration as general anæsthetics are so frequently followed by a day or a night of vomiting.

*The incision.*—The best incision is  $\frac{1}{4}$  to  $\frac{1}{2}$  in. below and parallel to the fold of the groin, about 2 in. long according to the obesity of the patient. Its centre is where a perpendicular dropped from the pubic spine intersects this line. The lips of the wound are steadily wiped apart by gauze swabs and this rapidly exposes the enlarged vein, which is defined for 2 in. as well as its three branches from above, which are divided between ligatures. A lymphatic gland usually lies over it. The main internal saphenous vein is exposed until its union with the femoral vein below it is visible, sufficient being dissected to determine that the latter is patent above and below. Saphena varices are singularly inelastic and gentle handling is essential, or torrential bleeding may follow; another reason why the operation must be in an equipped operating theatre with an assistant.

The internal saphenous vein is ligatured at its point of union with the femoral vein; No. 50 thread is used for this. To leave a stump of internal saphenous vein not only predisposes to thrombosis and an embolus, but recanalization may occur through unnoticed small branches.

*The injection of the vein.*—I have used three fluids for injection: sodium morrhuate, Maingot's solution of quinine and urethane followed by lithocaine, and recently ethamolin.

*Sodium morrhuate.*—Some of the few recurrences after this operation were where this fluid was used. Further, twelve years ago in one of my cases sudden death occurred and I have read of others. I know of a number of anaphylactic collapses. This fluid is of variable chemical composition; it is inefficient and dangerous and I urge that its use be discontinued.

*Quinine and urethane followed by lithocaine.*—This is a powerful combination. The dose varies, from 2 to 6 c.c. of each, which has produced good sclerosis. When using it for

*injection only* a point meriting mention is that quinine and urethane is lighter than blood, therefore it is injected at the lower end of the vein it is desired to sclerose. Lithocaine is heavier than blood; it is inserted at the upper end of the varicosity. The two intermingle and the thrombosis is palpable in the veins shortly after injection. Momentary dizziness caused from absorption of quinine occasionally occurs.

*Ethamolin.*—On the recommendation of Milnes Walker of Wolverhampton I have injected up to 10 c.c. when ligaturing and injecting. The thrombosis is not so widespread or so firm as the twin solution.

*Saline 30%.*—A solution of 30 to 40 c.c. of NaCl 30% has been used since November 1942; it is too early to report its permanent effectiveness, but it does give a fair thrombosis. Its advantage is its safety.

*The method of injecting the vein after ligature of the termination of the internal saphenous.*—Two methods are available. There is that of a puncture with a hypodermic needle and the sclerosing agent diffuses down the vessel. I have used this most and it has worked satisfactorily. It is particularly indicated where the internal saphenous vein is duplicated or its outer and inner branches are large and varicose, when it will distribute itself amongst them. The precautions in this method: (1) Fix the needle firmly on the syringe to save detachment during the injection with soiling of the wound with the irritant fluid. (2) It is easy to push a fine hypodermic needle through both walls of the vein and make the injection into the tissues beneath, with tiresome delayed healing. (3) Leakage into the wound from the puncture in the vein wall, so this is protected by momentary pressure of a small swab. (4) Occasionally in incompetent communicating veins the valve at the end of the internal saphenous vein is incompetent and the sclerosing fluid does not diffuse and the vein swells up. Method No. 2, now to be described, overcomes this.

*Method No. 2.*—This consists of the introduction for 12 to 18 in. of a ureteric catheter, or an ordinary gum elastic catheter or of a modified Walker Stevenson needle into the internal saphenous vein. The sclerosing agent is carried down the vessel around and below the knee. This technique was introduced by Unger in 1927, again by Kettel in 1931, and also recommended in this country by Oldham of Liverpool. In moderate cases it saves a second incision, ligature and injection above the knee. It may thrombose the veins to the malleoli. It also carries the fluid beyond competent valves in cases of communicating vein failure.

*The technique.*—The last 2 in. of the long saphenous vein is exposed, its upper end is tied, and a Spencer Wells is applied at the lower part. A ligature is then passed twice round the vein at the middle. The vessel is opened at the upper part and the catheter or special needle is inserted into it as far as the artery forceps. The ligature, until now lying loose, is tightened but not tied. The Spencer Wells is removed and the catheter or needle is threaded down the vein without blood leaking. Occasionally obstruction by the valves is felt but manipulation overcomes this and it is often possible to introduce it 12 in. The injection is 2 to 6 c.c. of quinine and urethane followed by 1 c.c. of sterile water to clear the needle or catheter followed by 2 to 6 c.c. of lithocaine, and whilst this is being introduced the needle or catheter is partially withdrawn. Forceful injection is used to spread the fluid as far as possible. The needle or catheter is then taken out, keeping the guard ligature tight to prevent loss of blood and soiling of the wound with the sclerosing agent, after which this ligature is tied.

The upper end of the vein is transfixed with fine thread in the same way as a hernial sac. This precaution is necessary, because occasionally the main ligature yields, and there is no guard between it and the right ventricle. The internal saphenous vein is divided below the double ligature.

*The toilet.*—The wound is cleansed to remove soiling with the sclerosing agent and also to determine complete hæmostasis. The dead space in the fat which in stout persons is considerable, is obliterated by two or three sutures. The skin is accurately closed and a firm pressure dressing is applied.

*A danger.*—A possible error in the operation is that of ligature and injection of the common femoral vein. On three occasions I have almost committed this. On the third I had tied and injected the femoral vein when the significance of its engorged state arrested attention. Investigation showed the mistake.

*The remedy.*—A temporary ligature was placed 2 in. below the first ligature, the vein was opened between two stay sutures, and the interior was irrigated. The lower ligature was momentarily released and the blood allowed to sweep out. The ligature was controlled again, the vein sutured and both ligatures removed. No untoward effects occurred either immediately or in three years afterwards.

*Ligature about the knee.*—In cases of extensive varicosities of the internal saphenous

vein below the knee, I have found superior results follow a second incision, ligature, injection and division immediately above the knee. This vessel is marked beforehand whilst the patient is standing and sometimes it is obscure on the deep fascia.

*The external saphenous vein.*—To ligature and inject the external saphenous vein, the patient lies on the face. The incision is the middle line longitudinally, centred at the crease of the knee. It is deepened through the fat and also the deep fascia as the last two or three inches of the external saphenous vein lie beneath the latter, occasionally even intramuscularly. This deep position explains why incompetence in this vessel is overlooked and why to constrict it effectively a tight tourniquet is necessary. The vein lies in a fatty bed between the heads of the gastrocnemius muscles and it is defined to its union with the popliteal vein into the popliteal space. There is a branch which passes upwards from the end of the short saphenous vein which must be ligatured for this branch feeds the clusters of varicose veins occasionally seen at the back and lower part of the thigh. Only by the two tourniquet tests can this be detected. The short saphenous vein is treated the same as the internal saphenous, taking care with the toilet, hæmostasis, obliteration of dead space, accurate closure of the skin and a pressure dressing.

Patients who have had one leg operated on are up in forty-eight hours. When both legs are done, they stay in bed for five to seven days.

#### COMPLICATIONS.

Complications are few and should be seldom. The mortality is so far nil. The complications are constitutional and local. (1) Occasional buzzing in the ears after the injection of quinine. (2) Post-anæsthetic malaise if a spinal or general anæsthetic, especially vomiting with the latter. (3) Post-operative pulmonary embolism occurred in two cases: one slight, the other moderate occurred after discharge from hospital, both caused indifferent health lasting two months. I believe that small emboli are commoner than is generally thought. (4) Post-operative debility especially in hard-worked housewives. The reaction is out of proportion to the operation performed.

The local complications are: *In the wound*, delayed healing and sepsis is the commonest. I emphasize this because the unnecessary incapacitation may last two to three months. The causes of this delayed healing are, I think, five: (a) The groin is a most potentially infected area especially in stout patients.

(b) Defects in asepsis and surgical technique including deputing the procedure to a house surgeon in an out-patient theatre. I respectfully urge that the diagnosis and treatment of varicose veins is worthy of a senior's time. It should be deputed only to trained dependable assistants. For consistent success the operation requires the care devoted to other major operations, whilst its benefits to patients are of a high order.

(c) Spilling of the injection fluid in the fatty wound.

(d) Hæmostasis is essential for hæmatoma can be considerable in the fatty distensible wound, besides which the clot is readily infected from the skin. The dead space in the fat is obliterated and a firm pressure dressing applied to prevent the oozing of blood.

(e) Lymphorrhœa: The groin is a lymphatic drainage depot. Some of these lymphatics are torn and the oozing from them (possibly infected from ulcer or eczema) is controlled by obliteration of the dead space and the pressure dressing.

By good preparation, adequate towelling, aseptic technique, hæmostasis, care with the sclerosing fluid, accurate sewing up and fixed dressing, the trouble has been abolished.

*Pain in the wound and leg.*—Pain and swelling in the wound and leg with severe chemical phlebitis and periphlebitis are occasionally met and are sometimes severe. Firm bandaging with elastoplast gives relief. Careful estimation of the injection fluid is necessary, some patients react excessively.

*Subcuticular varices and necrosis of the skin.*—Occasionally necrosis of the skin develops over thrombosed subcuticular varices with the discharge of clot. An elastoplast dressing or Unna's paste bandage relieves this and healing is progressive, and fortunately is quicker than after an injection ulcer.

*Eczema.*—Obstinate eczema around the ankle is a depressing presentation. It has been oftenest due to an incomplete diagnosis and incomplete treatment, incompetence of the external saphenous vein having been overlooked. Where this is absent, septic foci particularly dead teeth, infected wisdom teeth and septic tonsils are searched for.

*Residual œdema* after treatment of gross varicose veins always yields to the application of a Dickson Wright elastic bandage, of whose usefulness I cannot speak too highly.

*Unsclosed veins.*—Unsclosed veins in the lower half of the leg, especially round the ankle, frequently remain after only the high ligature in the groin: the second ligature

above the knee settles most of them and remnants respond to injection, subject to there being no incompetence of the external saphenous vein.

*The results.*—The majority of results are gratifying. The operation is exacting, it takes up to half an hour to tie and inject the internal saphenous vein at the groin and the knee. There is a trickle of indifferent results, some of my own and some of others which cast out complacency regarding the operation. The standard of cure has grown, the aim is to sclerose every varicose vein. This is difficult, especially with the varices around the ankle. The disappointments have been due to incomplete diagnosis. The internal and external saphenous veins are incompetent together oftener than was at first thought. No diagnosis of varicose veins is adequate without the two tourniquet tests being done.

*Recurrences of varicose veins.*—Recurrences of varicose veins after ligature and injection of the long saphenous vein are mainly due to ligature below the point of union with the femoral vein, failure to tie branches and variations in the anatomy. An adequate incision exposes these points and avoids errors. Small incisions should be rejected.

In closing I would emphasize the following points: (1) The necessity for a complete diagnosis of varicose veins; there are at least seven possibilities. (2) The need to up-grade the condition and the operation to a major one.

Dr. H. S. Russell said that he agreed with previous remarks about the prevalence of the condition. If the figure of 4% were to be accepted, though he thought this rather low, it would mean 12,000 cases in the city of Bradford, where he practised, and obviously all of these could not be treated by radical surgical methods.

Even if sufficient surgical teams were available, most of these people would be unwilling to lose three or four weeks' work as a result of operation, apart from the time spent on the waiting list, and in present circumstances he thought they were right, considering that the operation was one of election and not necessity.

In searching for an alternative before the war, he had read a paper by Mr. Dickson Wright on combined ligature and injection which seemed promising, but there was the difficulty of maintaining sterility in these out-patient cases and the method of subcutaneous ligature had been worked out.

In this method the vein was tied at the highest accessible point, bearing in mind that it could often be felt when it could not be seen. In the first place the patient stood while the vein was indicated on the skin by marking with an antiseptic dye, or even with an ordinary fountain pen. He then lay down, and two wheals were raised with novocain solution on either side of the vein at its highest discoverable point. A suture was then passed through these two wheals travelling under the vein in the process. A curved needle might be used for this, or the hypodermic needle method could be used.

An injection of sclerosing solution was then given at the same point. Dr. Russell had used most of these solutions, starting in 1927 with sod. salicyl., and found little to choose between them, except that quinine and urethane was apt to cause pain. Of late he had used mostly sod. morrhuate or ethamolin, both being quite dependable.

After the injection the suture was tied over a pad of gauze or other suitable material. It was necessary to deal with the tributary veins, but this should be left for a few days, until the extent of the thrombosis resulting from this first injection could be judged. It was usually greater than one would get from the injection alone. The suture was removed after four days.

One critic of the method had described it as "dangerous, painful, and useless to the patient". This, he thought, was nonsense. Major E. L. Farquharson (*Brit. med. J.*, 1942, ii, 453) had described 150 cases treated by this method without untoward consequences. Any pain which resulted was from the very successful thrombosis and not directly from the ligature. Anyone who had tried the method would agree that it was very far from being useless to the patient. Only the previous day he had seen a patient treated in June 1941 who had a subcutaneous ligature and a total of 4 c.c. of 5% sod. morrhuate solution with a satisfactory thrombosis from the ankle to a point just below the saphenous opening. This man said he had forgotten about his varicose vein. "It was finished."

In conclusion Dr. Russell pointed out that there was no competition between this method and more radical proceedings, but that it supplied a probability of cure to many who had no hope of cure by injection alone and no chance of Trendelenburg's operation.

JOINT DISCUSSION No. 2.

# Sections of Urology and Neurology

Chairman—H. L. ATTWATER, M.Ch.

(President of the Section of Urology)

[November 26, 1942]

## DISCUSSION ON THE TREATMENT OF THE PARALYSED BLADDER

Mr. F. J. F. Barrington, Mr. John Everidge, and Mr. A. Clifford Morson : This collective report is considered advisable because no single urologist is likely to have an extensive experience of the treatment of the paralysed bladder. The changes which occur in the bladder and at the internal meatus due to paralysis are well known to every urologist. However, it is important to remember that mucous membrane and muscle are devitalized, that ulceration may occur, and that the intramural portion of the ureter has lost its tone, and is therefore unable to prevent the regurgitation of urine. In some cases the urethral mucous membrane is also devitalized. Hence the impossibility of preventing cystitis, and the ever-present danger of death from septic pyelonephritis. It must never be forgotten that the overstretching of the bladder musculature during the flaccid or first stage of paralysis will jeopardize its power of recovery.

However skilled the treatment of the paralysed bladder may be it is unlikely that cystitis can be entirely prevented, nor does it matter if it is the only complication of the urinary tract. On the other hand sepsis can and must be controlled.

During the 1914-1918 war treatment by catheterization was almost the universal practice in France and other theatres of war. Those cases which survived the initial stages of the paralysis arrived in this country suffering from profound urinary sepsis. Most of them came under the care of the late Sir John Thomson-Walker. He insisted that the treatment must be suprapubic cystostomy. So convinced was he of the grave dangers of catheterization that he stated he considered it to be "the surgical failure of the war". It is with regret that we notice that those responsible for the memorandum on "Injuries of the spinal cord and cauda equina and their treatment" in the E.M.S. instructions issued by the Ministry of Health recommend frequent catheterization or, still worse, the tied-in catheter. Drainage by either is inefficient, and under war conditions the tied-in catheter is little better than a bung. Urethritis, prostatitis and epididymitis are common complications of this treatment. We are of opinion that suprapubic cystostomy, performed before the bladder has become damaged, will save more lives than any other method, for although some infection will result, the efficient drainage given by it transcends all the disabilities of this minor operation. To avoid the spread of sepsis to the prevesical tissues, the trocar and cannula technique with a limited dissection is to be recommended; this secures a watertight cystostomy. The opening in the bladder must be close to its apex. An angular tube of the White or Malecot variety should be used. The tube must be changed every ten to fourteen days. Frequent irrigations through the tube are necessary, supplemented by urethral irrigations if there is much phosphatic deposit. Alkalinity of the urine ought to be avoided by giving hexamine and ammonium chloride by the mouth as soon as the bladder paralysis is recognized. When the injury to the cord is in the dorsal region no anaesthesia is needed. If it is a cauda equina lesion it is best to infiltrate skin and abdominal muscles with 1% novocain. Should the latter not be available an excellent substitute is distilled water. The skin incision need not be longer than 2 in. After exposure of a small area of the summit of the distended bladder a finger is inserted in the wound to draw up the peritoneum. The trocar and cannula are plunged immediately below the finger through the anterior vesical wall close to its apex and directed towards the bladder base. The operation must not be a blind one. It is necessary that the trocar has a sharp point with cutting edges.

With this method of bladder drainage it is possible to convey the patient by stretcher, ambulance or train without fear of even temporary retention. In every hospital ship and casualty clearing station there should be a surgeon thoroughly familiar with the trocar and cannula technique of cystostomy.

Some authorities claim that the paralysed bladder can be drained efficiently by what is termed tidal drainage. This can only be satisfactory when managed by an intelligent and experienced team. On theoretical grounds it may have its attractions, but in practice, apart from the gross defects due to catheter mishaps, it is debatable whether the antiseptic really gets into the bladder in sufficient bulk to justify the extra trouble and

cumbersome material entailed by the use of the Munro apparatus or its modifications. Gangrene of the bladder has been known to occur as a result of this treatment.

As regards manual compression of the bladder, the E.M.S. instructions state that such attempts are dangerous and rarely successful. When the bladder is toneless there is considerable risk of rupturing its wall and setting up fatal peritonitis. We fully endorse these views. Are there any contra-indications to suprapubic cystotomy? It may be argued that when it is necessary to nurse the patient in the prone position as after laminectomy, a cystotomy wound with its tube is a great inconvenience. The modern angular tube fits snugly, not only in the bladder opening, but against the skin of the abdominal wall, and there should be no fear of leakage. How much more distasteful and disturbing to the patient is a tied-in catheter fixed in position by strapping round the penis. Moreover the urethra cannot retain it longer than a fortnight without the development of a purulent discharge, ulceration, and even peri-urethral abscesses; yet continuous drainage beyond this time is still imperative. In cauda equina lesions, where there is true incontinence excoriation of the skin of the penis and often of the scrotum occurs, no matter what type of urinal is worn.

If the bladder does not recover its function within three months of the onset of the lesion it is likely that the patient will be more comfortable with cystotomy drainage. Lastly it may be stressed that suprapubic cystotomy is inadvisable in all cases where there is a reasonable chance of recovery of the bladder function within a short time; but who can accurately determine what length that time will be? Recovery is rare in crushes from fracture dislocations, less rare in bullet wounds, and common in transverse myelitis, concussion and contusions of the cord. In certain circumstances, such as the removal of a tumour pressing on the cord, when the surgeon expects that function will be restored within a fortnight of the operation, catheterization can be adopted in preference to cystotomy.

So long as normal evacuation of the bladder is impossible there will be damage to the kidneys, unless the vesical pressure is reduced. A temporary cystotomy avoids this danger. The re-education of the bladder to function normally can be done by pegging the tube two to four hours daily. If urine escapes from the urethra during this time it is an indication that expulsive power is returning. The period of re-education may last as long as twelve months.

In the second or chronic stage of paralysis, as soon as the vesical pressure reaches a certain height automatic micturition occurs: this is well seen in the tabetic bladder. Provided there is no instrumentation the urinary infection is slight, but serious damage to the kidneys occurs under these conditions. It is advisable to check up the degree of this damage at intervals by renal function tests, and when they indicate that the kidney failure is becoming serious a suprapubic cystotomy is a necessity. Another complication of the automatic bladder is the formation of phosphatic calculi, which increase sepsis by their presence and interfere with the reflex discharge of urine.

To summarize our views: There is no serious contra-indication to suprapubic cystotomy for the paralysed bladder, whatever may be the cause, and we believe that more lives will be saved by this method of treatment than by any other.

Mr. E. W. Riches: *The treatment of the paralysed bladder.*—After any spinal injury with paraplegia the final stage of the bladder function may be one of voluntary micturition, or of automatic micturition. In rare cases there is permanent retention, and in even fewer permanent incontinence, but as the best treatment of both of these is by suprapubic cystotomy I shall say no more about them.

*Voluntary micturition* may develop after retention in partial lesions at any level of the cord or cauda equina. In its final stage it differs from the normal only in so far as it is modified by infection produced during treatment, and by the not infrequent presence of a small amount of residual urine. It can also be distinguished from a normal bladder by cystometry. This is the most desirable form of micturition to attain, especially if treatment has left the bladder uninfected.

*Automatic micturition.*—The working of the automatic bladder which follows injuries of the supralumbar cord differs from that which follows cauda equina lesions; lesions of the lumbar segments may produce either type according to their exact level and distribution.

After complete lesions at the higher level urine is passed by a periodic reflex. This act is entirely involuntary; it may rarely be preceded by a sensation of vesical distension but the warning is very brief; it may be set off by strain or movement. Urine is then discharged in a powerful stream which can neither be delayed nor interrupted by the patient, nor can he feel it passing through the urethra. The act may occur at intervals of from fifteen minutes to three hours.

This is a most undesirable form of micturition: the patient is usually bedridden and

must keep a urinal in place at all times if he is to avoid a wet bed to aggravate the pressure sores which are probably already present. Such patients are much better served by a suprapubic cystotomy.

The type of automatic micturition which follows lesions of the cauda equina is less highly developed than the periodic reflex bladder of cord lesions, depending as it does on a peripheral reflex mechanism uninfluenced by intact segments of the cord. It takes longer to appear; distension of the bladder can usually be appreciated and there is a warning period, often of several minutes, before urination. The act is then started by straining; this produces secondary contractions in the detrusor and a good stream is passed as long as the straining is continued and until the bladder is completely or almost completely emptied. The patient usually remains dry until the next evacuation which may be from one to four hours later, and by regulating his fluid intake he is frequently able to go through the night undisturbed. If the bladder is allowed to overdistend an involuntary contraction takes place and it empties reflexly. This form of micturition is quite compatible with a reasonably normal life for a man, and for some women.

Thus if micturition is to be performed through the normal channel the only satisfactory methods are the voluntary act, or the poorly developed periodic reflex of a cauda equina lesion, sometimes called the autonomous bladder. The periodic reflex of a spinal lesion is better replaced by suprapubic cystotomy, and this being so it is surely wise in these cases to do the cystotomy at as early a stage as possible, before the advent of ascending infection. Should the case subsequently prove to have an incomplete lesion the presence of a suprapubic tube will not prevent the return of voluntary micturition if other factors allow it, and the fistula will close quickly.

The main urinary obstacles to the development of a satisfactory autonomous bladder or the return of voluntary micturition are infection, leakage of urine and overdistension of the bladder. *Infection* is the most important, and its importance lies not so much in the cystitis produced, although this delays the development of the micturition mechanism, as in the fact that infection in a bladder which cannot empty freely leads to a rapid ascending infection and pyelonephritis. This is a condition which will kill the patient either in its acute stage, or, if it becomes chronic, at a later stage from chronic urinary sepsis with or without stone formation. Infection is introduced by catheterization, and sometimes by the first and only catheterization; there are in conditions of war many reasons why a proper aseptic technique cannot be maintained. *Leakage* of urine over anasthetic areas will increase the liability to and severity of pressure sores and will thus contribute to the general illness; the combination of urinary sepsis with deep sloughing bedsores gives rise to a grave state of toxæmia from which full recovery is unlikely. Leakage of urine may result from the stage of overflow incontinence which develops at a varying interval after the initial complete retention, but it may also follow a badly performed suprapubic cystotomy. *Overdistension* of the bladder is probably the least important factor and is only dangerous if prolonged; then it may lead to a permanent loss of tone in the detrusor which defeats the object in view. It has been stated that overdistension may lead to sloughing of the whole bladder mucous membrane, but I have never seen such a case; it would appear to be a possibility if the bladder were infected by catheterization and then allowed to become distended again. During the last war a few cases were left distended for as long as four days and still developed automatic micturition without infection (Vellacott and Webb-Johnson, 1919). Overdistension may continue for an indefinite period before overflow incontinence occurs; the average period of retention was given by Thomson-Walker (1917) as fifty-five days, but it is not clear if this included the stage of retention with overflow. In a series of cases in this war the average period of retention was fifteen days.

*Treatment.*—The treatment required for the bladder will depend on the stage at which the case is seen and the surgical facilities immediately available. In the early stage of complete retention when facilities are likely to be absent there is no immediate need to empty the bladder, and it can safely be left for at least twenty-four hours; this is contrary to the accepted teaching that the passage of a catheter must never be neglected. I would rather say that in no circumstances must a catheter be passed under such conditions. If there is further delay overflow incontinence is likely to develop, and this does not introduce infection nor gross overdistension; its only disadvantage is the effect of leakage of urine in promoting pressure sores. If after twenty-four hours it has not developed, and circumstances are still unfavourable, and particularly if the patient is in pain then suprapubic aspiration with a lumbar puncture or serum needle should be done with aseptic precautions, and a note made of its time so that it can be repeated in six hours. Further aspirations if necessary must be at shorter intervals and there is probably a limit to the number before extravasation occurs. When the patient reaches better surgical surroundings suprapubic cystotomy should be done, and it is most important that the fistula should be made high, at a point half-way between the umbilicus and symphysis. This



can easily be done through a short transverse incision at this level, but for the occasional operator a vertical incision may be preferred provided it occupies only the middle two-fourths of the line joining the umbilicus and symphysis and that the tube is brought out at the mid-point of the incision. The commonly advised puncture just above the symphysis always leaks, at least for the first week and often for months, and it allows the bladder to contract unduly. The high incision gives a long oblique track which is watertight and which prevents the bladder from sinking into the pelvis. A low suprapubic cystotomy is rather like a badly planned amputation in that it is unsatisfactory for the provision of an appliance and it cannot be altered except by a drastic operation. The establishment of a proper suprapubic fistula will not prevent the development either of voluntary micturition or of a periodic reflex although it may delay it in cases where the nerve injury is incomplete. It will not prevent infection of the bladder, in fact some degree of cystitis is inevitable, but it will prevent pyelonephritis if properly cared for. The former is curable, the latter not. The subsequent treatment of the case is relatively easy from the bladder point of view and will include urinary antiseptics and lavage. This may be done by an automatic tidal drainage apparatus when the fistula is properly sealed round the catheter.

If the patient can be transferred in the first twenty-four hours to a properly equipped hospital or more particularly to a special centre where such cases are concentrated the treatment may be different, and it is only under these conditions that catheterization should be allowed. If the nerve lesion appears slight regular intermittent catheterization may be done with a proper ritual for a limited period not exceeding two days. Good results have been obtained in some cases by this method in the special centres. If there is no voluntary or automatic micturition after this period the method must be abandoned and replaced either by high suprapubic cystotomy or by an indwelling urethral catheter with tidal drainage. I have left any mention of this method until the end; with scrupulous care, constant attention, and an intelligent patient it is perfectly satisfactory, but an ineffective tidal drainage is worse than useless and will rapidly be followed by ascending infection. Cystometric measurements should be made in order to determine the filling pressure required for each type of bladder.

In conclusion, the worst cases of urinary infection I have seen in this war have followed the prolonged use of an indwelling catheter, but they are closely followed by those treated by intermittent catheterization. This appears to be still the most popular method in general use both at home and in the field for the initial treatment, and it has frequently led to an incurable infection which is present before the patient reaches a special centre and which eventually kills him.

#### REFERENCES

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VELLACOTT, P. N., and WEBB-JOHNSON, A. E. (1919) *Lancet* (i), 733.

**Mr. A. Sutcliffe Kerr:** The majority of the 65 cases of spinal injury which have been treated in an E.M.S. Spinal Injuries Centre were admitted some weeks or months after the initial injury. An opportunity was thus afforded to see the intermediate and late results of a variety of methods of initial treatment. Overflow, manual expression, intermittent catheterization, tied-in catheters and low suprapubic cystotomy have all given very bad results.

A high suprapubic cystotomy is satisfactory and is probably the most generally useful method for treatment of paraplegic patients under difficult conditions in war-time. In our experience, however, it does not offer the positive advantages of a tidal drainage apparatus. After long and very satisfactory experience with the Munro Drip type we have recently adopted the Bellis type as modified by Captain O. W. Stewart, R.C.A.M.C., in the *Lancet*, 1942, (i), 287, and have found it even more efficient and simple to control.

Where a patient has the good fortune to be admitted to a well-equipped hospital immediately after his injury we believe that tidal drainage should be instituted at once, as it will prevent the onset of urinary sepsis, the patient is kept dry, he can be turned for nursing at will, and the musculature of the vesical wall is forced to adopt its normal physiological rhythm of expansion and contraction.

It is a striking fact that although a tied-in catheter is employed in tidal drainage we have not seen a single case of clinical urethritis following its use.

**Mr. C. A. Wells** suggests that a possible explanation for this may lie in the fact that the tied-in catheter allows a small pool of stagnant urine to collect just above the internal sphincter and that infection spreads from there by gravity into the posterior urethra and thence to the whole urethral canal along the wall of the catheter. With tidal drainage the urine can never stagnate owing to the positive filling and emptying of the bladder at regular intervals and the focus for urethritis is thus removed.

Urinary calculi occurred in only two cases—neither of whom had had tidal drainage. Apart from the use of ammonium chloride to maintain acid urine, oral urinary antiseptics do not appear to be of much value.

The regime recommended is: (1) If possible establish tidal drainage as soon as interference with bladder is discovered. (2) Under difficult conditions perform a high suprapubic cystotomy. (3) If this is impossible perform suprapubic aspiration by a serum needle (as recommended by Mr. E. W. Riches) but do not repeat more than once. In very late stages where an automatic bladder does not become established and it is evident that recovery is not going to occur a high suprapubic cystotomy becomes the method of choice.

**Mr. H. P. Winsbury-White:** Some very important lessons were learned as the result of treatment of these cases during the last war; it would certainly be a pity if we failed to benefit by them: (1) First of all that regular catheterization sooner or later sets the patient on the downward path in the majority of cases. (2) That suprapubic cystotomy is eminently satisfactory when carried out early and with a technique which ensures a watertight drainage, and when the watertight drainage is maintained during the convalescence.

With catheterization bad results are obtained even when the strictest precautions are taken with regard to asepsis, and prolonged indwelling catheter drainage will at a later date lead to urethral stricture.

With regard to an operative technique which will produce watertight drainage, Mr. Morson's trocar is eminently satisfactory but there is an even simpler apparatus whereby a Malecot tube with a reinforced end is introduced into the bladder by means of a sharp pointed trocar. (Screen demonstration.)

During the convalescence considerable supervision is essential if watertight suprapubic drainage is to be maintained. It is so easy for a self-retaining tube to be dragged out of the bladder, especially if it drains into a bottle at the side of the bed. As a precaution I prefer to drain the tube into a bottle between the thighs. When it is advisable to change from the self-retaining tube to the permanent suprapubic apparatus complete watertightness can still be maintained if the precaution has been taken to see that the last self-retaining tube is several sizes smaller than the tube of the permanent apparatus. The importance of preventing leakage round the tube cannot be over-emphasized, as it is not difficult for bed-sores to occur with a fatal result if leakage supervenes.

**Mr. K. I. Nissen:** With regard to initial treatment I do not think that aspiration of the bladder will find general favour. As a rule, urinary excretion is depressed for a period after the accident. The bladder can safely be allowed to distend well up to the umbilicus, by which time the patient will be under hospital conditions.

Tidal drainage should be reserved for hospitals where the skill and attention given is of a high order. It can follow a short period of careful intermittent catheterization, but is contra-indicated in established sepsis, when suprapubic drainage should be performed without delay. Urinary sepsis developing during tidal drainage may be masked by dilution. Again it is an indication for radical drainage. Stewart's modification of the Bellis apparatus is simple and excellent. The capacity of the tubing is small, and there is no doubt that the irrigating fluid enters the bladder.

Suprapubic drainage is of greatest use under Service conditions. The sloping track given by inserting the tube well above the pubis hardly leaks at all. The wound heals normally, however severe and high the paraplegia. In cases recovering urinary control, the tube is spigoted for increasing periods till the bladder capacity is good and the residual urine low. The fistula is then allowed to close spontaneously and may be expected to heal within two weeks. Normal function can be regained after drainage for as long as a year.

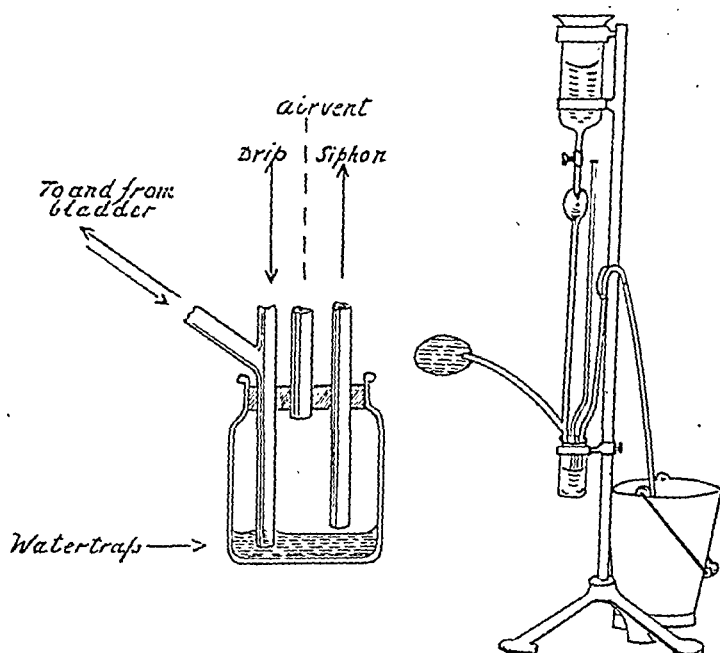
Stone formation follows prolonged recumbency in traumatic paraplegia with distressing frequency. No form of drainage need interfere with the frequent turning of the patient from one side to the other during the day. The high suprapubic tube allows a plaster jacket to be applied with full purchase over the pubis, and a recovering patient may then be allowed out of bed. Similarly, tidal drainage may be interrupted during the day. Plaster beds, though most useful at times, tend to interfere with mobilization of the trunk as opposed to the limbs, and should be discarded as soon as possible in favour of a sorbo mattress and frequent turning.

**Mr. Charles Wells:** I have seen tidal drainage in use and have been greatly impressed with its efficacy.

It is important to distinguish between conditions obtaining in the field and those obtaining in civilian practice, including the treatment of air-raid casualties. In all cases, it is certainly right to condemn the use of a catheter. In the field it is probably right

to advocate suprapubic drainage as being simple, straightforward and universally applicable. In the remaining cases, however, the position is different and it is a mistake to reduce all treatment to the same level unless one is satisfied that the method advocated is on all counts the best method. Tidal drainage should not be condemned out of hand before it has been seen in use. In the hands of Mr. Kerr and his colleagues, neither sepsis nor urethritis has occurred.

Mr. Wells then described a simplification of the Munro apparatus and also mentioned the importance of using a catheter small enough to fit loosely in the urethra. The apparatus he described ensures constant drainage by means of a simple water trap and can be more easily set up than other forms of apparatus in common use (see fig.).



Mr. C. P. Sames: I have had a limited experience of tidal drainage at St. Mary's, using a modification described by Laurie and Nathan. I cannot say that I have found the freedom from infection so universal as one is led to suppose, although I am interested to hear the suggestions put forward as to why this might be expected. However, it would seem to me that one still has the universal bogie of indwelling catheters, namely urethritis and possibly danger of stricture formation. The major cause for urethritis is surely not so much direct bacteriological infection but the diminishing local resistance as the result of trauma from the constant friction of indwelling catheters. The penis and catheter, however well fixed—there is no ideal method yet described—are never for a moment at rest. Following upon the first principles of orthopaedics it might be desirable but perhaps a little impracticable to immobilize the penis and catheter and surrounding parts in plaster of Paris.

Mr. Clifford Morson: I am pleased to note that the majority of the speakers supported the cystotomy treatment and stressed the importance of the correct position of the fistula. I see no reason to withdraw my criticism of the Munro apparatus and its modifications. Such treatment means partial immobilization of the patient over a long period which leads to urinary stasis and therefore an increase of sepsis and the danger of lithiasis. An important adjunct to a trocar and cannula cystotomy is that it enables the patient to sit in a chair, from the commencement of the treatment. Mr. Sames' explanation of the cause of urethritis with an indwelling catheter being due to constant friction is of course the correct one. I regret that Mr. Riches, in an otherwise excellent survey of the paralysed bladder, should advocate suprapubic puncture with a serum needle to be repeated at intervals; in the majority of cases this method will lead to prevesical cellulitis.

## Section of Urology

President—H. L. ATTWATER, M.Ch.

[October 22, 1942]

*Specimens were shown as follows:*

**Mr. A. Wilfrid Adams:**

- (1) Carcinoma of Right Ureter. Total Nephro-ureterectomy in December 1939.
- (2) Hydronephrosis from Past Focal Septic Nephritis.

**Mr. J. Scholefield:**

- (1) Congenital Obstruction in the Posterior Urethra. (2) Urethral Foreign Body.

**Mr. T. J. Millin:**

Hypernephroma of One Kidney; Solitary Cyst of Opposite Kidney.

**Mr. Douglas F. Freebody:**

Carcinoma of the Adrenal Cortex.

**Mr. Alex. E. Roche:**

- (1) Calculous Hydronephrosis. (2) Calculous Hæmatonephrosis with Squamous-cell Carcinoma and Hyperpiçsis. (3) Hæmorrhage into Solitary Renal Cyst.

**Mr. J. Gabe:**

- (1) Wilms' Tumour. (2) Multiple Renal and Ureteric Calculi in a Child of 6 Years.

**Mr. E. W. Riches:**

Ossifying Retroperitoneal Fibroma.

**Mr. Hugh Donovan:**

Colon Showing Injury in Fatal Case of Acute Mercurial Poisoning Due to Absorption of Oxycyanide of Mercury from Urinary Tract During Per-urethral Resection of Prostate.

E. T., aged 51. Admitted with acute retention. Indwelling catheter.

Blood urea: 36 mg.%. Urea concentration test: 2.4%, 3.0%, 3.0%.

*Operation.*—Per-urethral resection of small adenomatous prostate carried out by the McCarthy instrument six days later; duration of procedure about one and a quarter hours. Lotion used 8 pints of 1:10,000 solution of mercuric oxycyanide. Nine hours later onset of severe rectal hæmorrhage caused exsanguination and collapse; transfused with 2 pints of blood with improvement. Urinary secretion maintained. Urine contained only a haze of albumin and no casts.

Relapse began on fourth post-operative day with distension, vomiting and continued diarrhœa. Twenty-four-hour specimen of urine collected from sixth to seventh day did not show any mercury. Death occurred on the tenth day.

The illness was apyrexial; there was no salivation; tenderness in the lower abdomen was noted in the earlier stages.

*Post mortem.*—The essential finding was a colon whose whole lining mucosa was infiltrated with blood and, in places, the site of superficial necrosis. The prostatic cavity and bladder had the usual appearance. There was some thickening of the perivesical tissues. The ureters and renal pelves were not dilated.

The pathological report on the large intestine, liver and kidney was made by Professor G. Haswell Wilson.

*Examination of the large intestine.*—In the fresh state the mucous membrane throughout the whole extent of the large intestine was black in colour. This appeared to be the result of a hæmorrhagic type of enteritis with subsequent darkening of the hæmorrhage by post-mortem changes. The whole thickness of the mucous membrane was soft and pulpy and the underlying muscle was exposed in places. There was no suppuration and the appearances did not resemble those of any kind of infective enteritis. They corresponded in every respect to those produced by acute mercurial poisoning.

The mounted preparation presents a somewhat different appearance as the greater part of the necrotic material has been lost in the preparation of the specimen. The mucous membrane shows a crumbling dis-integrating appearance with ulcers extending down to the muscular coat. Some irregular congestion is apparent owing to the exposure of the submucous plexus but the appearances do not suggest any of the ordinary types of enteritis.

Microscopic examination of the intestine reveals almost complete necrosis of the epithelial lining. Only occasional small clusters of epithelium still persist. The

greater part of the necrotic material has been lost but the superficial part of the bowel still shows a considerable layer of necrosis and in relation to this there are many vessels of considerable size, some of which are implicated in the necrosing process. There is remarkably little inflammatory reaction and only a suggestion of any attempt at repair. A small amount of what appears to be fibrin is scattered through the oedematous submucous layer. Considered as a whole the changes suggest that the necrosis has been the result of chemical rather than toxic action.

*Examination of liver.*—The liver shows evidence of early portal cirrhosis and in addition there is widespread cloudy swelling and oedema with occasional cells which appear to be completely necrotic and some small areas of bile stasis.

*Examination of kidney.*—The substance of the kidney is oedematous and there is a trace of albuminous exudate in some of the Bowman's spaces but there is no other striking change in the glomeruli. Extensive damage is present in the epithelium of the convoluted tubules and Henle's loops. In these the condition of the epithelium varies from cloudy swelling with some loss of nuclear staining to complete necrosis and partial disintegration of the affected cells. Coagulated albuminous material and epithelial debris are present in some of the tubules at a lower level.

It is to be noted that in the fresh state the liver and kidneys appeared to be anæmic but they showed no gross evidence either of toxic damage or the effects of sepsis and the gross changes were limited to the mucous membrane of the large intestine.

Presumably several ounces of the solution of the mercury salt must have been absorbed.

[January 28, 1943]

*Cases and Specimens were shown as follows :*

Major F. A. Simeone, U.S.A.M.C.:

Tuberculous Kidney.

Major James M. Campbell, R.C.A.M.C.:

Sulphapyridine Anuria. (Case Report.)

Capt. Van Wyck, R.C.A.M.C.:

Bilateral Hydronephrosis.

Mr. Louis R. Chaiken :

Spontaneous Rupture of the Bladder.

Mr. O. E. J. McOustra :

Calcification of Kidney and Ureter.

Mr. E. W. Riches :

Carbuncle of Kidney.

Mr. R. H. O. B. Robinson :

Bilateral Renal Calculi. (From Two Cases.)

Mr. D. Lang Stevenson :

Giant Bilateral Renal Calculi.

Mr. Alex. E. Roche :

Nephro-ureterectomy for Large Ureteric Calculi.

Mr. A. Wilfrid Adams :

Massive Calculus in Vesical Diverticulum.

Mr. J. Gabe :

Foreign Bodies Removed from Bladder.

Mr. F. McG. Loughnane :

(1) Ectopia Vesicæ. (2) Genital Tuberculosis. (3) Cyst of the Prostate. (4) Cystic Calculi.

Mr. Clifford Morson and Mr. R. Blunden :

Ureteric Transplantation into the Bowel and Total Cystectomy for Carcinoma of the Bladder.

Mr. G. H. C. Ovens :

Stone (3¼ lb.) Successfully Removed from Bladder.

Mr. H. P. Winsbury-White :

Vesical Diverticulum.

## Section of Anæsthetics

President—A. W. MATTHEW

[December 4, 1942]

### The Oxford Vaporizer in Routine Hospital Practice

By FRED A. B. BANNISTER, M.A., M.D., D.A.

THE Oxford vaporizer has now been in regular use in the Radcliffe Infirmary for about two years. Cases anæsthetized with it have not been specially selected.

*Premedication.*—The average adult patient has usually had morphia gr. 1/6, hyoscine gr. 1/150, given one and a half to two hours before operation. Children under 10 have generally had atropine only. In many cases, basal anæsthesia has been produced, for children, with nembutal by mouth, gr. 0.6/14 lb., for adults, with avertin 0.08 to 0.1 c.c./kilo body-weight, or with pentothal given intravenously immediately before ether given as the main anæsthetic. Any difficulties experienced during induction have been related chiefly to premedication in the form of morphia incorrectly given, i.e. given too near the time of anæsthesia.

*Induction.*—Most commonly induction has been by ethyl chloride to ether anæsthesia, ethyl chloride being sprayed into an induction bag, now a standard part of the equipment. Nitrous oxide can be used for inducing anæsthesia by admitting it to the apparatus from a cylinder attached. After avertin or pentothal, ether anæsthesia may be started at once, or ethyl chloride used as an intermediary. Vinesthene-ether or trilene-ether sequences have also been used.

When using ether alone, the patient will soon tolerate 2% ether, delivered to him by pressing on the concertina-bag before the mask is lowered on his face. It should not be lowered until he has had several breaths and become analgesic. When he is breathing 2% easily and deeply, the percentage can be raised gradually, allowing about four breaths on each higher percentage until the depth of anæsthesia required is attained. For abdominal operations, to be sure anæsthesia is sufficiently deep, the average fit patient should have tolerated 25% ether for two or three minutes before the surgeon begins. Thereafter a much lower maintenance percentage can be used, e.g. 7% to 12%.

Ethyl chloride should be used so that surgical anæsthesia is just attained, and the change then made to ether, when 15% is usually tolerated.

Where anæsthesia has been begun with avertin or pentothal, about 5% ether is usually inhaled without disturbance, and the percentage can be increased from this as before.

*Use and limitations of the machine.*—This machine was designed for ether anæsthesia. It can be used for any type of case in contrast to closed-circuit anæsthesia which cannot be used satisfactorily unless the circuit can be made gas-tight and which is therefore not a method for operations on the throat, for example, where the Boyle-Davis gag is used. The machine can also be used instead of open-drop ether which is not practicable for prolonged operations in the region of the head and neck.

By means of the reservoir (concertina) bag the machine can be used as a resuscitator when required.

With the Oxford vaporizer good ether anæsthesia can be given by an inexperienced person under supervision, thus enabling an anæsthetist to supervise several cases at once. This may be of advantage also for the single-handed surgeon (e.g. on board ship) who can induce the anæsthesia himself and then allow an assistant under his supervision to continue with it while the operation is carried out. Hence those using the apparatus can

quickly be trained to adjust the dose of ether so that the lightest possible level of anaesthesia satisfactory for the operation is maintained. It is true that the skilled anaesthetist can achieve this satisfactorily with almost any apparatus, even with open-drop ether; but with other apparatus, e.g. with the Boyle's machine, far more experience is needed to give a good anaesthetic. The inexperienced anaesthetist often maintains too deep a level of anaesthesia—which usually means unnecessary and prolonged post-operative depression.

Anaesthesia here compared with ether anaesthesia achieved by other means, resembles most closely that of the closed-circuit ( $\text{CO}_2$ -absorption) method. Ether from the vaporizer reaches the patient at about room temperature and the air inhaled with it is partly saturated with water vapour.

The degree of anaesthesia is easily controlled and ether may be administered in measured concentrations adjustable to any required value by a single control which, once adjusted, gives an almost steady percentage of ether. A difficulty with ether which often leads to the maintenance of too deep a level of anaesthesia is, that when keeping a light level, an unexpected, strong surgical stimulus may disturb anaesthesia and lead to its rapid lightening, with perhaps straining or coughing. With ether alone it is then difficult to deepen anaesthesia again without disturbing the surgeon. To prevent this upset, I have found it useful to test the patient every five to ten minutes in the following way: for an abdominal operation on a fairly fit adult, where after a quarter of an hour or so the maintenance value may be about 7% ether, the test is made by pushing the control lever rapidly to 25%, and keeping it there while the patient takes two breaths only of this percentage, then returning it to the maintenance percentage. If anaesthesia has lightened unduly, then three or four breaths after this stimulus there will be a momentary disturbance of the rhythm of respiration, or the patient may swallow. This does not lead to any change which disturbs the surgeon, but is a warning that the level of anaesthesia is too light and should be deepened at once by increasing the ether percentage gradually, allowing four breaths on each higher percentage until the test no longer produces any response. The maintenance percentage will then need to be higher for a short time, but later may be reduced again. For extra-abdominal operations it is not necessary to advance the lever to 25%, during testing, since this is a very strong stimulus; usually I make 15% the testing level for such operations.

*Disadvantages.*—These are merely those of ether generally, however it is given: explosibility; a (possibly) greater tendency to post-operative sickness (especially as compared with such general anaesthesia as pentothal followed by nitrous oxide and oxygen for extra-abdominal work) and a tendency to laryngeal spasm in light anaesthesia.

There are some practical points to be remembered with this apparatus: (1) Before using, and from time to time during use, check the thermometer to ensure that the apparatus has been "charged" with heat before use. Otherwise the percentage of ether the patient receives is less than that shown on the indicating lever. (2) Induction with this machine using ether alone is more rapid than with open-drop ether. (3) The ether percentage shown is accurate to an average of 1.5% with an adult patient inspiring ether from the machine at an average rate and depth of respiration.

*Post-operative findings.*—A careful follow-up of cases, a daily routine in the Radcliffe Infirmary, Oxford, has failed to show any difference between ether anaesthesia from the Oxford vaporizer and ether anaesthesia by other means.

#### SUMMARY

The Oxford vaporizer, used for about two years, has proved itself an eminently practical machine for ether anaesthesia, portable and not requiring cylinders of nitrous oxide and oxygen. Any condition of general anaesthesia required and for which ether is not contraindicated because of explosion risks, has been obtained satisfactorily with it. By the possibility of using ether in any required low concentration new aspects of ether anaesthesia are revealed. The occasional anaesthetist can learn to give safer and better anaesthetics with this than with many other machines now available.

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[February 5, 1943]

## R.C.A.M.C. Anæsthetic Experiences : Dieppe Raid Casualties, August 19—20, 1942

By Colonel B. C. LEECH, E.D., R.C.A.M.C.

This report of the experiences of several R.C.A.M.C. anæsthetists, covering those Dieppe casualties who were brought back to England, has been prepared primarily in order to provide permanent record; secondly with the purpose of giving our Canadian anæsthetists themselves a complete picture of what took place and how problems were met in a few of our military hospitals.

The raid on Dieppe (August 19, 1942) called the "Jubilee Operation", was a reconnaissance in force, and was undertaken as a combined operation with Navy, Army and Air Force co-operating. It had been carefully planned and thoroughly rehearsed in great detail. Medical arrangements for collection, first-aid treatment, evacuation to home ports and reception therein, of an anticipated large number of casualties, were also carefully prepared and rehearsed. That these could not be carried out as planned was entirely unpredictable.

The miserable luck of a chance encounter during darkness, and only a few miles off the French shore, between some of our forward vessels and a tiny German coastwise convoy, had a very serious effect upon the whole operation. These forward vessels carried Commando troops whose special job was to silence an important battery of artillery which could cover the Dieppe beach from our left. The enemy was thus warned and alarmed. Few of this party ever succeeded in making a beach landing, and those who did were unable to silence these gun positions.

In spite of this, the main thrust went straight on as planned, but the resulting losses were very heavy. Collecting posts, under shelter of the breakwater, were manned by regimental medical officers, but the open beach, which had to be crossed in order to place casualties upon the landing barges, was swept by enfilade fire from rifles, machine guns, mortars and artillery. Even after being loaded with wounded many of these craft were sunk by shell-fire after pushing out into varying depths of sea.

Most of the returning Canadian wounded reached Canadian military hospitals or casualty clearing stations in this country, and a few reached British hospitals. Many of the wounded who got back had been in the sea once or even twice, having had landing barges sunk beneath them. Practically all wounded who were successfully returned came back aboard destroyers under the unforeseen conditions of crowding and limited medical care.

Splendid work in unloading these ships and giving urgent first aid at the docks was carried out by two Canadian field ambulance units (one of which had hurriedly to move 15 miles in darkness and in rain and set up again on the docks in order to handle the destroyer-borne wounded). Here réchauffement, hot drinks and adjustment of dressings took place, and the patients were loaded into Canadian motor ambulance convoys and taken to Canadian military hospitals, the nearest of which were from 22 to 40 miles inland. One ambulance train was used, and carried patients from the South Coast to an inland area.

For security reasons our military general hospitals were not advised of the operation until approximately 0725 hours on the morning of August 19, 1942. Preparation was then hastily made for the immediate handling of surgical cases to be spread among five of our general hospitals. Two casualty clearing stations were also prepared for handling minor cases.

### THE CASUALTIES

Of the casualties brought in, 65% were found to be in need of immediate surgery requiring anæsthesia. Of the remainder, several were considered hopeless and the balance not urgent. Multiple wounds were the rule rather than the exception, and were caused by bomb or shell fragments, and also by repeated woundings. The different hospitals reported that from 50% to 100% of their cases suffered from multiple wounds; average incidence approximately 62%.



A rough anatomical classification of the cases receiving immediate operation is as follows. (*Note*.—Any case may appear in two or more classes):

Intracranial	... ..	= 1.5% approx.
Intrathoracic	... ..	= 2.5% approx.
(15 additional cases not operated)		
Intra-abdominal	... ..	= 2.0% approx.
(At least 6 additional cases not operated, 5 resulting in early death and 1 in recovery following subsequent drainage of pelvic abscess)		
Extremities with compound fractures	... ..	= 30.0% approx.
Multiple wounds (estimated)	... ..	= 62.0% approx.

(*Note*.—The above leaves us uninformed as to the relationship of these figures to the total incidence of intracranial, intrathoracic and intra-abdominal woundings which may have been inflicted, an answer which, of course, can never be obtained.)

The influence of exposure to the elements upon these casualties can only be estimated by the fact that many wounded were subjected to drenching in cold sea water for varying periods; and also by the time factor. Time elapsing between trauma and induction of anaesthesia for surgery varied from twelve to fifty-eight hours, the average being thirty and a half hours. Pre-operative shock was treated in 10% of cases. Of these only about 1% were noted as being in serious shock or collapse.

#### ANÆSTHESIA

The hospital centres handling these casualties consisted of the following: Five general hospitals, R.C.A.M.C.; two specialized hospitals, R.C.A.M.C.; two casualty clearing stations, R.C.A.M.C.

At each of the above centres practically all types of modern anaesthetic agents and methods were available, including, in each, one or two Heidbrink gas machines equipped with carbon dioxide absorption; and both cyclopropane and nitrous oxide were freely available. Also at each centre at least one specialized anaesthetist was at hand.

The ten anaesthetic specialists at the above nine centres were augmented, at some time during the rush period, by five additional specialists borrowed, with surgical teams, from other hospitals which were not directly involved in the action. Further assistance in anaesthesia was variously supplied during the emergency by the following: seventeen medical officers (including a pathologist and an otolaryngologist); and one dental officer. Neither nursing sisters nor nursing orderlies were used in any way as anaesthetists.

In only one hospital did an anaesthetic specialist have to undertake the administration and supervision of more than one case at one time.

Surgical teams consisted usually of:

1 surgeon	} or, if available	2 surgeons
1 anaesthetist		1 anaesthetist
1 nursing sister		2 nursing sisters
1 nursing orderly		1 nursing orderly

or, for many minor cases, 1 surgeon, 1 anaesthetist, 1 nursing orderly.

Surgical teams seem to have worked in shifts, differing in each hospital, e.g.:

Hospital "A"—8 hrs. on duty, 8 hrs. off, repeated over 40 hrs.

Hospital "B"—20 hrs. duty, including 2 hrs. rest.

Hospital "C"—27 hrs. duty, with time for hurried meals only.

Hospital "D"—36 hrs. duty, with 2 hrs. rest period and hurried meals between cases.

Hospital "E"—4 hrs. duty, 2 hrs. off, repeated.

The flow of patients to the operating rooms was controlled differently in almost every hospital. In some, the Officer i/c Surgery, or his assistant during rest periods, studied all cases together with radiological findings, &c., and tagged each case in order of priority, sending along a hastily scribbled note of direction to the operating room. In other centres, the surgeon of each team went to his particular ward, or wards, during his off-duty periods and assessed his cases ready for his next turn in the operating room. In still others, senior officers of the medical division took on the ward work in the surgical division, and directed the flow to the operating rooms.

Likewise, the ordering of pre-anaesthetic medication was variously handled in different

centres. Generally speaking, this was ordered by the ward medical officer in accordance with routine previously established by the anæsthetist, or was ordered after brief consultation with the anæsthetist in special cases. At any rate, every anæsthetist reports that he was fully aware of what premedication had been given to each case, and the time at which it was administered. This information, in written form, accompanied each patient to the operating room.

The drugs most generally used for premedication were: Morphine with atropine, or omnopon with scopolamine. Rectal avertin was used as premedicant for several of the cases done under local tissue infiltration.

*Agents.*—The emergency anæsthetic procedures here reported can be analysed according to agents used, as follows:

Agents	Cases %
Intravenous pentothal-sodium alone ... ..	51.25
Intravenous pentothal supplemented by:	
(a) Nitrous oxide ... ..	3.50
(b) Cyclopropane ... ..	
Cyclopropane, alone ... ..	25.25
Cyclopropane, with pentothal induction ... ..	
Cyclopropane, plus ether ... ..	2.75
Nitrous oxide—oxygen, alone ... ..	—
Nitrous oxide—oxygen, plus ether ... ..	1.00
Open ether ... ..	6.50
Procaine HCl, infiltration ... ..	7.25
Avertin and procaine field block (cranial) ... ..	0.50
Avertin and nitrous oxide—oxygen (cranial) ... ..	0.50
Spinal analgesia ... ..	1.50
Total ... ..	100.00

*Methods.*—Pentothal-sodium was given intravenously only by the fractional (syringe) injection method. Cyclopropane was given by closed endotracheal method for open chest, cranial, face and intra-abdominal procedures.

Other procedures were by ordinary methods.

*Maintenance and recovery periods.*—Four cases of collapse on table occurred. All responded to ordinary treatment.

One case of post-operative shock was reported, which resulted in complete recovery. Three cases (all abdominal) died within forty-eight hours; these deaths were in no way attributable to the anæsthetic procedures. One case of lobar pneumonia recovered. Two instances of acute bronchitis were reported, with recovery. Nausea and vomiting were reported in only 15 cases, 8 of which had been given open ether.

No other sequelæ were reported.

*"Sulfa" drugs and anæsthetic agents.*—In answer to the question: "Were there any disquieting effects observed (particularly in pentothal cases) in patients who had been given any of the 'Sulfa' drugs?" each centre replied "None".

*Remarks and suggestions by anæsthetists* (some directly quoted).—(1) "Surprisingly small quantities of anæsthetic agents required for these men. Fatigue is probably the explanation." (2) "Suggest 3 oral airways for each team." (3) "Pentothal-sodium used in 92 of our 96 cases. Results excellent." (4) "Local infiltration analgesia used in 25 of our 26 cases in this casualty clearing station. All were minor sitting or walking cases." (5) Non-specialist, acting anæsthetists who served during the emergency employed the following agents: Open ether; pentothal; pentothal, gas-oxygen, ether. These acting anæsthetists were given cases which did not require much muscular relaxation and no difficulty was experienced in their handling the above agents. (6) For purposes of permanent record and review, all nine reporters favoured a standard simple form of anæsthetic chart and record card, separate from present Army forms.

#### SUMMARY

The medical story of the Dieppe operation of August 19, 1942, is briefly presented. Anæsthetic experiences are analytically recorded. The employment of surgical teams is reported. It is apparent that many surgical teams treated this operation as a set piece, and decided to see their jobs through, rather than to organize themselves for prolonged work.

Individuality is evidenced on the part of specialized anaesthetists, but all seem to have achieved uniformly good results.

Additional emergency anaesthetists were readily available.

Our anaesthetic specialists are interested in acquiring a method of uniform charting and recording for purposes of statistics and study.

#### CONCLUSION

From our experiences with the Dieppe casualties, we may say that in handling war casualties intravenous pentothal-sodium can (and likely will) take care of upwards of 50% of anaesthetic demands.

In the hands of experienced specialists we feel that cyclopropane (often embracing endotracheal technique) is the anaesthetic of first choice for most surgery of the head, neck, chest and abdomen; whenever profound muscular relaxation is needed; and when dealing with patients who are in shock.

Spinal analgesia for emergency surgery does not seem to be as useful as we expected. In cases where shock (perhaps latent shock) might be a factor, its use may become limited to lower extremity surgery. In other words, paralysing the adrenals by high spinal block does not seem justifiable in these cases.

Ether still remains the safest agent in relatively unskilled hands, and hence it will likely always serve a very important function. And here the Oxford vaporizer may prove valuable for the maintenance of anaesthesia by temporary, inexperienced anaesthetists.

Local tissue infiltration, done by the surgeon, may come to be used in many cases of minor surgery of the soft tissues, especially when the services of an anaesthetist are not readily available.

It seems that nitrous oxide is no longer a popular agent with Canadian Army anaesthetists. It is felt that anaesthetic specialists in Army hospitals and casualty clearing stations would do well to train several medical officers of their units in the use of ether and of intravenous pentothal-sodium.

It is hoped that by so doing, anaesthetic administrations in the Army will never have to be assigned to anyone who is not a graduate in Medicine.

## Section of Orthopædics

President—B. H. BURNS, F.R.C.S.

[December 1, 1942]

### DISCUSSION ON PAINFUL BACK IN SOLDIERS AND IN INDUSTRIAL WORKERS

**Mr. Robert Young :** The majority of patients with backache have pain referred down the leg from time to time, and it is not possible to keep backache and sciatica (using the term sciatica in its widest sense of pain down the leg) in separate compartments.

Sir Thomas Lewis and Kellgren have shown by the injection of hypertonic saline into the muscles and ligaments that the pain so produced is referred in a segmental manner and is accompanied by tenderness of the muscles where the pain is referred. They also showed that pain arising in superficial structures was felt locally. The strength of the stimulus and the depth of the point stimulated are the principal factors which determine the extent of the referred pain. Steindler, Kellgren, Cyriax and others have since confirmed these observations in the clinical field.

We have found that of those patients with referred pain down the leg, the majority have lesions of the muscles, fasciæ or ligaments. Only a certain proportion have lesions of the nerves or perineural structures. A few have lesions of the joints, still fewer have lesions of the bones.

It is difficult to classify backache on a pathological or ætiological basis. The ætiology is so uncertain, and the exact pathology is, for the most part, still unknown, and has therefore to be guessed at. For instance, the same clinical lesions of muscles, fasciæ or ligaments may be due to a number of different ætiological factors such as injury, postural strain, and inflammation, which are difficult to differentiate. The anatomical features are, however, less in doubt, and the classification we have found most useful is one on an anatomical basis.

There are two main groups.

The first includes those patients with referred pain from the abdominal or pelvic viscera. These are distinguished by having a full and painless range of movement of the spine and hips. Also included in this group are those patients with various neurological diseases.

In the second group are those patients with pain due to a local condition in the back. This group is further subdivided into those in whom the pain arises in (a) muscles, fasciæ and ligaments (majority); (b) nerves or perineural structures—perineuritis, neuritis; (c) intervertebral or sacro-iliac joints, e.g. arthritis; (d) bones—inflammatory, neoplastic or Payer's disease.

TABLE I.—TOTAL NUMBER OF PERSONAL RECORDS 770 (St. Thomas's, 497; Botleys, 273).  
ST. THOMAS'S HOSPITAL, 1936-9.

Number of patients, 497. Male, 238; Female, 259.		
Localized pain in back	Referred down leg	Referred round trunk
206	204	87

The Botleys Park cases which I shall discuss in detail contain a large proportion of Service and industrial workers. The St. Thomas's series was representative of ordinary general hospital out-patients and shows two points very well. Contrary to what may be expected, since it has been commonly thought that backache is much more frequent in women than in men, there were only 30 more women than men. 206 had localized pain, whereas 291, nearly half as many again, also had referred pain.

TABLE II.—BOTLEYS PARK ORTHOPÆDIC CENTRE, 1940-42.  
Number of patients, 273.

Service	...	...	...	M.	201	Localized pain in back	...	62
				F.	5	With referred pain	...	144
Civilian	...	...	...	M.	48	Localized pain in back	...	25
				F.	19	With referred pain	...	42

As in the St. Thomas's series those with referred pain outnumber those with local pain. The high proportion of males is due to the great number of Service patients. But even in the civilians the males outnumber the females three times.

Individuality is evidenced on the part of specialized anaesthetists, but all seem to have achieved uniformly good results.

Additional emergency anaesthetists were readily available.

Our anaesthetic specialists are interested in acquiring a method of uniform charting and recording for purposes of statistics and study.

### CONCLUSION

From our experiences with the Dieppe casualties, we may say that in handling war casualties intravenous pentothal-sodium can (and likely will) take care of upwards of 50% of anaesthetic demands.

In the hands of experienced specialists we feel that cyclopropane (often embracing endotracheal technique) is the anaesthetic of first choice for most surgery of the head, neck, chest and abdomen; whenever profound muscular relaxation is needed; and when dealing with patients who are in shock.

Spinal analgesia for emergency surgery does not seem to be as useful as we expected. In cases where shock (perhaps latent shock) might be a factor, its use may become limited to lower extremity surgery. In other words, paralysing the adrenals by high spinal block does not seem justifiable in these cases.

Ether still remains the safest agent in relatively unskilled hands, and hence it will likely always serve a very important function. And here the Oxford vaporizer may prove valuable for the maintenance of anaesthesia by temporary, inexperienced anaesthetists.

Local tissue infiltration, done by the surgeon, may come to be used in many cases of minor surgery of the soft tissues, especially when the services of an anaesthetist are not readily available.

It seems that nitrous oxide is no longer a popular agent with Canadian Army anaesthetists. It is felt that anaesthetic specialists in Army hospitals and casualty clearing stations would do well to train several medical officers of their units in the use of ether and of intravenous pentothal-sodium.

It is hoped that by so doing, anaesthetic administrations in the Army will never have to be assigned to anyone who is not a graduate in Medicine.

Without the head and knee test we have found it impossible to distinguish between the myofascial lesions of the buttock and lower part of the erector spinæ and lesions of the perineural structures. The straight leg raise test is of little value because it is positive in all myofascial lesions of the buttock. It will be positive in lesions of the lower part of the erector spinæ, since at a certain point, depending on the length of the hamstrings, the pelvis will be rotated and the lumbar spine flattened. Raising the leg to the point at which pain is felt and then dorsiflexing the foot is also of no help since this is painful in a normal individual. The head and knee test is not quite 100% effective, though it is very nearly so. In a very few patients with an associated muscle lesion in addition to the lesion of the perineural structures, it has been possible to abolish the muscular component by local injection of novocain, leaving a true, positive head and knee sign.

Complete rigidity of the spine is usual in arthritis of the intervertebral joints and in spondylitis. Inflammatory and neoplastic disease of the bones can only be excluded by X-ray examination.

The tests we rely on for pain arising in the sacro-iliac joint are compressing, separating and rotating the ilia on the sacrum. This does not involve stretching or compressing any muscles, or putting strain on other joints. In early cases of spondylitis before ankylosis of the joints has taken place, this test has been always positive in our experience so far. We have also found it positive in other patients with arthritis in the sacro-iliac joint. Other tests sometimes employed, and, I think uselessly, for pain arising in the sacro-iliac joint, such as laying the patient on his side, rotating the pelvis forward and the shoulders back, will be positive in most lesions of the erector spinæ or lumbar spine. Laying the patient on his side, flexing the sound leg on the trunk, and then forcibly extending the affected hip is also unsatisfactory, since it is not possible completely to immobilize the lumbar spine by this method and extension of the hip will be painful in lesions of the buttock and the hip-joint.

Local tenderness is present in all the myofascial lesions. It is not always a feature of the other two groups. In fact some of our patients have no tenderness at all, either in the lumbar region or down the course of the sciatic nerve. Tenderness down the course of the sciatic nerve in myofascial lesions may be due to tenderness of the muscles deep to the area of referred pain.

More accurate localization of the myofascial lesions can be obtained by a careful consideration of the particular movements that are limited and the resisted movements that are painful. The lesion is thus localized to the particular muscle and the muscle is then palpated for tenderness, and if injection of this area with novocain relieves the symptoms the diagnosis is confirmed. If superficial tenderness is not abolished, and still more if tenderness is increased, then the symptoms must be hysterical.

This aspect of differential diagnosis helps to determine the site of origin of the pain. Other factors concerned with the pathology and ætiology of the lesions are: History. postural deformities, X-ray examination, septic foci, laboratory tests.

We have found the history of little value in the diagnosis of the type of lesion, though it is of value in elucidating the ætiology, particularly with regard to the question of injury and septic foci.

Postural deformities and X-ray examination will be dealt with by other speakers.

Search for a septic focus is always important, particularly when the blood sedimentation rate is raised. In our patients we have found that the most common sites of sepsis are the nose and throat, teeth, tonsils, and particularly grossly septic antra. In none of our patients could we attribute the lesion to the large gut, and in only one to the prostate.

*Laboratory tests.*—Blood sedimentation rate: A raised B.S.R. is an indication to search for a focus of infection, including X-ray examination of the chest.

We have had two patients with silent carcinoma of the lung and one with a silent tuberculous cavity of the lung, in whom X-ray examination was undertaken because the B.S.R. was raised.

Wassermann reaction and gonococcal complement fixation test are done as a routine in all our patients, but in only one was the latter test of any significance.

#### TREATMENT

Patients with acute myofascial lesions are given a period of rest in bed, during which we give an injection of novocain into the tender spot, repeated in three to four days' time. Heat and massage are also given. As soon as the acute symptoms have subsided the patients are put on graduated physical treatment, and when fit they have a period of full gymnastic exercise before returning to their units, or (if they are civilians) to work.

Patients with chronic myofascial lesions are treated in a similar manner, without the rest in bed. We employ manipulation under anæsthetic only in those patients who after an initial improvement fail to make further progress.

TABLE III.—TYPE OF LESION.

Service Civilian	Muscle, fascial or ligamentous lesions 103 22	Peri- neuritis 31 8	Neuritis 32 32	Various 40 5
<i>Analysis of Various.</i>				
T.B. Spine ... ..	3	? Sacralized L.5 ... ..	2	2
Spondylitis ... ..	6	Osteo-arthritis, hip ... ..	3	3
Functional ... ..	8	Osteo-arthritis, spine... ..	3	3
Diagnosis uncertain ... ..	15	Coccydynia ... ..	2	2
Sacro-iliac arthritis ... ..	3			

This shows an analysis of the type of lesion. The muscle, fascial or ligamentous lesions account for half the total in the Service patients and a third of the civilians. The high proportion of cases of neuritis in civilians is due to the fact that only the more serious or more long-standing cases were sent to Botleys.

*Muscle, fascial, or ligamentous lesions.*—This category includes lumbago, sacro-iliac strain, lumbosacral strain and a large number of sciaticas. We do not use the term sacro-iliac strain for those cases merely with tenderness in the region of the posterior superior spine. Here the lesion is in the overlying muscles or fascia. Pain arising in the sacro-iliac joint is very uncommon except where radiographs show evidence of disease. The tender points associated with these lesions do not conform to any special pattern. The majority are situated in the erector spinæ or buttock muscles. Some are in the interspinous ligaments. One particular point of tenderness is frequently found in the region of the gluteus medius muscle and is associated with pain down the leg, particularly down the outer side of the calf. As well as arising spontaneously it occurred in almost all our patients with fractures of the pelvis, the symptoms making their appearance soon after the patient commenced to walk. A diagnosis of sacro-iliac arthritis is not infrequently made, but injection of novocain into the tender spot has, in all our cases of fractures of the pelvis, completely and permanently relieved the symptoms.

The exact pathology of all the myofascial group is unknown. When subsequent to injury, they are muscle or ligamentous tears. Other pathological lesions include postural strain and inflammatory or rheumatic foci.

The term perineuritis is used where there is some affection of the perineural structures. The evidence for this is the eliciting of pain on stretching the sciatic nerve. Where there are in addition neurological signs, e.g. diminished or absent ankle-jerk, muscular weakness and alteration of sensation, the term neuritis is used. Some of the cases of neuritis are due to pressure, such as from prolapsed disc, and this may be true of some of the perineuritis cases. As in the myofascial group, doubtless a certain number are due to rheumatic or inflammatory foci, and then the lesion is in the perineural tissues.

Of the 45 classified as various the 15 unknown were characterized by limitation of movement of the spine, no local tenderness and a normal X-ray. They may have been lesions of the intervertebral joints or more likely lesions of the muscles or ligaments too deep to give local tenderness. One interesting feature of this group is that they correspond with a similar group in the St. Thomas's series numbering 68. In the Botleys cases all were relieved by graduated physical treatment with or without manipulation, and this was true of the majority of the St. Thomas's cases.

Eight cases were purely functional or hysterical with no organic basis. But there were hysterical manifestations of varying degrees superimposed on an organic basis in many more—about 25 %.

The two cases of sacralized lumbar 5th transverse process have been queried because we are still uncertain whether the symptoms could be ascribed to this or not. In 6 others the process was certainly not responsible for the symptoms.

In distinguishing between the three common types, muscle, fascial and ligamentous lesions on the one hand and lesions of the nerve and its sheath on the other, there is one sign of fundamental importance, that is the head and knee test. The patient sits on a stool with his back and head straight. The affected leg is then gradually straightened by extending the knee until the pain is felt. The leg is then bent (flexed at the knee) only just enough to relieve the pain. The head is then bent forward without moving the spine. This stretches the spinal cord and its coverings and hence the sciatic nerve and its roots, and the erector spinæ. If pain is now felt it will therefore be due to stretching one or other of these structures. The knee is then further flexed while still keeping the head bent. If the pain is then relieved it must be due to stretching of the sciatic nerve, its roots or coverings. If the pain is still unrelieved by flexing the knee, it must be due to stretching of the erector spinæ or its fascia since these are the only structures left on the stretch.

or oxygen, because it shows up the whole suspected area of the canal, but except with the best technique the outline of the air content is not easily defined and its behaviour cannot be watched during movements of the patient under the screen. The majority of workers favour lipiodol. Two or three cubic centimetres of this is injected into the lumbar canal and the patient then screened while being erected, inverted or rotated on a moving table. Lateral bending of the patient towards or away from the side of the painful extremity may release a column of lipiodol which is held up in the straight position.

The temptation to prolong the screening in order to watch the movements of the lipiodol should be checked, particularly if repeated examinations are made, because of the dangers of the cumulative effect of the radiation. The injection of 10 c.c. of thorotrast as an opaque fluid medium for investigating the spinal canal has recently been revived. Its use was discontinued because its radioactive properties were said to carry a carcinogenic danger but attempts to secure freedom from the latter have been made by washing out the thorotrast after the examination. B. H. Nichols (1942) claims to have used this method in more than 200 patients and found it accurate in diagnosis and localization. The method visualizes the whole canal and radiographs can be taken in antero-posterior, postero-anterior, lateral and oblique positions.

*Interpretation of the radiographs.*—The radiographs must be systematically examined in a general survey when the following points are noted: (1) the alignment of the vertebrae; (2) the outlines and internal structures of the transverse processes; (3) the vertebral extremities of the ribs; (4) the bodies; (5) the spinous processes; (6) the pedicles; (7) the articulations; (8) the discs; (9) the ligaments; and (10) the adjacent soft tissue structures. Failure to do this routine examination may well result in failure to detect an important lesion. The discovery of a lesion may indicate the necessity for further radiographs to secure additional evidence.

*Alignment of the vertebrae.*—Exaggeration of normal curvature should be noted. Angulation or interruption of the normal curvature between the elements of the column usually indicates a definite organic lesion or congenital deformity. The importance of radiographs soon after accident cannot be over-stressed, particularly in cases for compensation. In a previous paper I recorded (1936) the notes of a patient whose radiographs immediately after an injury were interpreted as showing a recent fracture of the 1st and 2nd lumbar vertebrae and treated accordingly with prolonged immobilization. Three years after he sought heavy compensation because of persistent pain and disability. It was possible to prove to the satisfaction of the court that the original radiographs showed the lesion to be an old one and evidence that an award of a large sum had been made several years previously, was subsequently obtained.

Three types of displacement of the vertebral bodies apart from those associated with scoliosis have been seen.

The first type is illustrated by the radiographs of a man W. C., aged 40. On June 2, 1936, he was struck in the lumbar region with a heavy weight. Antero-posterior and lateral radiographs of the back on the same day showed no definite fracture or displacement but he had obviously suffered a severe injury to his back and had temporary paresis of his lower extremities. The patient continued to have pain in the back and a further radiograph February 23, 1937, showed some narrowing of the disc space between the 12th dorsal and 1st lumbar bodies and forward displacement of the lower vertebral column from this site. Four months after, the disc space was considerably less and on the antero-posterior radiograph ossification of the ligaments on both lateral aspects of the disc was now very marked. Progressive ossification of the disc and its bordering ligaments has continued and now the two vertebrae are fused in a rather better alignment and most of the symptoms have ceased.

The second type is illustrated by W. H., aged 46 years, who complained of pain in the left hip and thigh and leg which had increased in severity during the past three months. He gave a history of severely straining his back while lifting a heavy weight. Radiographs showed a forward displacement of the upper spinal column on the 5th lumbar vertebra associated with a separation of the laminae and inferior facets of the 4th lumbar. The appearances suggest that the dissolution was due to fracture and this is supported by the ossification of the ligaments surrounding the disc. In spite of block leather support he continues to complain of pain. This was aggravated recently by a fall.

I have seen no such case in which progressive slipping has resulted in the lowest surface of the upper column rotating to face the anterior surface of the upper bodies of the lower column as we see in true spondylolisthesis, though this deformity is sometimes described as such. Balensweig (1927) described a similar case in a labourer aged 45 years, who slipped down some steps whilst he was carrying a load of wood. Schmorl and Junghanns have illustrated (1932) the lesion in male and female patients aged 68 and



Patients with perineuritis are treated in the same general way as the myofascial group, except that in place of local injection we give epidural injections of 100 c.c. 1% novocain. We do this both in the acute and the chronic stage, and repeat if benefit results. Manipulation under anæsthetic to increase the straight leg raise is only carried out if there is no spontaneous pain (that is no pain at rest), but only on movement. Patients with spontaneous pain have an active inflammatory lesion which will be aggravated by manipulation, but those with limited straight leg raise and pain on movement only are, we believe, suffering from the results of past inflammation, possibly adhesions, which can be broken down by manipulation.

**Neuritis.**—Patients with neuritis are treated with rest in a plaster bed, and epidural injections. If they are considered by the neurologist to have prolapsed disc, our procedure is: Service patients, if they have a long history, are boarded out of the Army, after their immediate symptoms are relieved. Those with a short history, if improved by treatment, are down-graded for a period of three months, after which their case is reviewed. In civilians, if the symptoms warrant it, we proceed with investigations for prolapsed disc and remove it if found. Otherwise they are treated with rest, physical treatment, fitted with a supporting belt, and allowed to return to light work. They are kept under observation. Laminectomy has been carried out on 15 of the 103 patients with symptoms referable to the sciatic nerve or its roots. 11 patients were immediately cured and have remained so since, 3 were cured at the end of three months, and one was not improved. In 9 cases definitely prolapsed discs were removed; in 2 others the symptoms were thought to be due to thickened sub-flavum ligament; these were both immediately cured by the operation: and in 4 cases nothing abnormal was found.

In all patients disclosed ætiological factors are dealt with.

**Results of epidural novocain injections in 54 patients.**—In a very few cases, that is 6 of the 54, the results were dramatic and all signs and symptoms were completely abolished, and the patients either went back to duty or back to work after one or two weeks' graduated physical training. 27 of the 54 were improved immediately and this improvement continued over a period of time. In 9 symptoms and signs were either completely relieved or improved, but recurred, usually within twenty-four hours, and in 12 the injection had no effect.

(A few slides were then shown illustrating the immediate results of local and epidural injections with novocain.)

**Results of treatment in 183 Service patients.**—(Still under treatment, 23.) Boarded out of the Army, 79; discharged to Unit, 84; regraded, 20.

The 84 patients discharged to their Unit were sent back in their original category. The 20 patients who were regraded were either down-graded permanently or for a period of two months.

**Dr. James F. Brailsford:** It must be recognized that the radiographs of the majority of patients with painful backs show little or no departure from the normal, though many radiographs show sufficient to justify the examinations. A negative radiological report may mean (a) that there are no changes in the bones or joints sufficiently developed at the time of the radiographs to show a change in the normal structure, (b) that the examination has not been efficiently done or (c) that the radiographs have not been accurately interpreted. Organic diseases such as tuberculosis, gastric ulcer, diverticulitis, carcinoma and others, are frequently associated with pain in the back and call for radiographic investigation. There is another type sent for X-ray examination of the back. It is a patient who complains of pain in one or other extremity which on clinical examination is sufficiently normal to suggest that the cause is more centrally placed. In one case sent for X-ray of pelvis, then spine, then skull. I learned that extensive biological and bacteriological investigations had been made on his spinal fluid, blood, sinuses, &c., before a radiograph of the femur showed that the cause of the pain in the thigh was an osteomyelitis of the femoral shaft.

**Radiographic technique.**—The preliminary examination should include antero-posterior and lateral radiographs of the painful area. These should be obtained preferably with a rotating anode tube used in conjunction with a Potter-Bucky diaphragm of a patient who keeps perfectly still during the exposure. Immobilization of the part with a band may secure sharpness of detail which might be lost without. If these radiographs suggest any abnormality further radiographs of the suspicious area should be taken, preferably with the aid of a cone to localize the radiation to the area. Radiographs with the central ray obliquely directed may be indicated as essential for demonstrating the suspicious areas such as the articular facets. Additional points have to be considered in those cases in which the spinal canal is examined after the injection of some foreign matter, whether it be a radiotransparent gas or a radio-opaque liquid. Some authorities advocate air

the vertebral bodies affected by secondary carcinoma do not show the expansion and pressure deformities which characterize Paget's disease. Secondary carcinoma of the prostate may show osteolytic properties and a whole vertebra may undergo dissolution without detection. Goldthwait (1933b) has stated that "Pain in the back, or backache, in the first place almost always represents trouble with the structures of the spine and is rarely ever due to disturbances with the viscera." It sometimes happens that a spinal lesion is associated with pain or discomfort which is referred to the viscera. In one case which showed complete disintegration of the 3rd lumbar vertebra, the patient had had an oral administration for cholecystography and the report had stated "no filling". The spinal lesion was overlooked and because of the atypical symptoms he was sent to me for an intravenous cholecystography. This was not done because the preliminary radiographs showed the complete destruction of the 3rd lumbar vertebra. Primary carcinoma of the prostate was suggested and examined for, but without success. Nine months after it was revealed by suppression of urine.

Angioma of a vertebra may cause persistent backache for many years. In one case I observed for ten years the patient was rarely free from discomfort. The radiograph shows the typical bone change.

Deformities of the outlines of the vertebral bodies may be produced by the so-called prolapses of the nucleus pulposus. For the most part these appear to be due to inherent defects in the disc itself, particularly the cartilaginous plates. They are so commonly found that it is difficult to assess their relationship to pain in adults.

Erosion of the anterior surfaces of the vertebral bodies is a more definite indication of the cause of pain. It is produced by aneurysm, tuberculous or other chronic abscess, hydatid cyst or adjacent tumour.

Erosion by tuberculous abscesses spreading under the anterior common ligament in the dorsal region is usually recognized because these abscesses are generally associated with well-defined paravertebral abscesses which displace the medial borders of the lungs laterally, but in the lumbar region the appearances may cause some difficulty in diagnosis. Erosion of the vertebral body by a developing hydatid cyst is a more uncommon lesion.

Many years ago I pointed out (1927) that pain in the back may be due to arthritic changes in the false joints which develop between spinous processes which are forced into contact with one another by exaggeration of the normal lumbar curvature. Bastrup (1936) has since published a series of cases showing this lesion.

The outlines of the pedicles as shown on the antero-posterior radiograph may reveal the only radiographic evidence of a lesion within the spinal canal. Unless this examination is included in the routine such lesions will be missed, for the pedicle lies behind the body and on a plane with the facets, and alterations in its detail are not at once apparent. Tumours within the spinal canal may produce pressure absorption of the adjacent walls of the pedicles and radiographs show evidence of widening of the canal by the increase in the interpeduncular width. The articulations of the vertebrae show the same type of change in various types of arthritis as other joints, i.e. pointing of the articular margins, narrowing of the joint spaces, sclerosis of the approximated bony surfaces and osteophytic outgrowth around the articular margins. Radiographs taken in oblique positions sometimes give additional evidence.

There is a form of "arthritis" which I first recorded in the sacro-iliac joint. It is associated with sclerosis of the subarticular bone without any apparent change in the joint surface or diminution of the interosseous joint space, i.e. the articular cartilage. The pain persists for years and does not respond readily to treatment.

*Lesions of the discs.*—There has been a change in opinion since Beadle reported (1931) "that they occur most frequently in the lumbar region and are really prolapses of the whole discs, but they do not project far enough to cause clinical symptoms". He reported posterior prolapses of the discs in 15.2% of 368 cases. Because of the phenomenal success in surgical removal of some of these protrusions some years ago the pendulum swung to the other extreme and these prolapses of the discs were credited with causing many of the aches and pains in the back and lower extremities (see Inman and Saunders, 1942). They emphasize the fact that a ruptured disc is accompanied by a similar injury to the ligaments around the interpeduncular foramen which is not modified by removal of the disc fragments. The State Compensation Insurance Fund of California reports (Kinney, 1942) compensable disability in 100% of patients operated upon for disc injuries.

Pain in the back may be associated with other tumours of the spinal canal, simple and malignant. They can be demonstrated by lipiodol injection into the canal. The kyphosis which develops in some cases following laminectomy may be associated with increased symptoms. Degenerations of the disc are associated with inflammatory changes following trauma or infection. The discs of the whole column undergo degeneration in early adult life in alcaptonuria.

82 years, but even at these ages there is little evidence of progressive slipping. As in the case (W. H.) described above, his cases show ossification of the surrounding ligaments and bosses of bone suggesting old trauma. It should, however, be noted that in some instances bony union does not exist between the neural arch and the body of the 4th lumbar vertebra. I published (1929) photographs and radiographs of a specimen of this defect in the 5th lumbar vertebra. A similar specimen of the 4th lumbar vertebra used to be in the collection at the Royal College of Surgeons. In this no displacement had occurred and the radiographs of the elements placed in contact did not reveal any sign of the lesion. I think that abnormal strain at the weak joint results in rupture of the fibrous union and associated ligaments with displacement and subsequent ossification of the damaged tissue and pressure deformities on nerve trunks.

The third type is similar to the second except that the displacement occurs, apparently from the same cause, at the lumbosacral joint and is usually called spondylolisthesis though this does not show the progressive slipping which is seen in the young female. The trauma may not have been sufficient to lead to radiographic examination and only after the development of symptoms in association with ossification of the damaged ligaments and sclerotic reactive bone changes in the approximated surfaces is the lesion discovered. The latter are probably brought about by the progressive increase in the strains of adult life, and result in a painful back. Because of the insidious development of the symptoms the nature of the lesion may not be recognized. I found it in a soldier who, because the reason for his complaints had not been appreciated, had been sent to a psychiatrist for treatment.

Opinions differ as to the frequency of this lesion. Sir Arbuthnot Lane regarded it as the normal condition in coal heavers. Meyerding has recorded over 600 cases at the Mayo Clinic. In the large industrial areas of Birmingham and the Midlands I do not see more than half a dozen a year, often less.

*Pseudo-fracture of the 4th dorsal vertebra.*—I have seen several patients who complained of pain in the back treated as fractures because the radiographs showed what was interpreted as a crush fracture of the 4th dorsal body. The misleading radiographic appearance is brought about by the neck of the scapula and glenoid being superimposed over the 4th dorsal body.

Pain in the back is usually associated with the transverse processes of the 5th lumbar vertebra which develop abnormal characters and come to articulate with the ilium and sacrum. In a number of cases the symptoms developed only after the increased strain of adult life and the radiographic appearance suggests that the pain was due to development of arthritis in the abnormal joint. Unusual expansion of a transverse process, the cancellous structure of which had been wholly destroyed and replaced by coarse bony trabeculations, has been seen in cases of osteoclastoma. Arthritic changes in the costo-transverse articulations indicated by pointing and lipping of the articular margins and sclerosis of the approximated bony surfaces are the only radiographic indications in some cases of painful back.

Localized separation of the posterior extremities of the ribs and widening of the intervertebral foramina are found in association with hour-glass or dumb-bell shaped neuroimata growing into or from the spinal canal.

*The vertebral bodies.*—In assessing the value of radiography as a means of identifying lesions of the vertebral bodies it must be realized that considerable destruction to the internal structure can occur before the radiograph will detect any change and even when the radiograph shows evidence this is easily overlooked. In those cases in which manipulation is contemplated it is most important to exclude any such change, otherwise fracture and marked aggravation of the symptoms will result.

If there is one region of the spine in which the changes are more liable to be missed than any other it is the sacrum. Lesions of the sacrum are frequently missed as the bone detail may lie hidden by the contents of the rectum and bowel.

Diffuse changes in the structure of isolated vertebral bodies may occur in Paget's disease, secondary carcinoma, lymphadenoma, angioma, meningioma. Paget's disease appears to show acute and chronic phases. In the former the disease is associated with decalcification, an increase in bulk and softening of the bone, consequently the affected bodies are compressed and prominent nerve symptoms may develop. In the chronic phase of the disease the bodies show an increased density, some increase in bulk but lesser pressure deformities.

With secondary carcinomatous metastases from the prostate, œsophagus or stomach, single or multiple rounded islands of increased density may be detected. These increase in size and eventually the whole vertebral body is changed and resembles the chronic form of Paget's disease, but owing to the fact that the lesion runs a more acute course

## Section of Therapeutics and Pharmacology

President—R. D. LAWRENCE, M.D.

[November 10, 1942]

### DISCUSSION ON WATER METABOLISM IN SICK AND HEALTHY INFANTS

Dr. Winifred F. Young [Summary]: When infants are suffering from gastro-enteritis a knowledge of their water metabolism becomes all important; the prevention and the relief of dehydration being the most difficult parts of their treatment. Dr. McCance and I have been studying the function of the kidney in the early weeks of life. The results of this work have shown that the excretory function of the kidney is still in a developmental stage and that an infant is only able to maintain the stability of his internal economy if he has enough water available for excretion. It is no chance provision of nature which gives a baby plenty of water with his food.

A full-term baby contains 75 to 80% of water; an adult only 60 to 65%. Furthermore, about 65% of the body water in infants is extracellular, but only 28% in adults. The mineral pattern of the extracellular and intracellular fluids is, however, the same throughout life. A baby requires much more fluid per kg. of body-weight than an adult and even on a basis of surface area the fluid intake ought to be higher. This is not because the losses by the skin and lungs are abnormally high: these are lower per square metre of surface area in new-born infants than they are in adults. The urine volumes, however, should be considerably larger. This fact is to be correlated with our discovery that the infant's kidney is a relatively ineffective organ particularly at low urine flows. We have found that the urea and mineral clearances per square metre per minute are always low at birth, and that they diminish still further if the minute volumes are small. They are lower in premature than in full-term new-born infants, but they increase towards the adult level during the first year of life. It is a well known clinical observation that premature infants are very liable to œdema and their low mineral clearances are an obvious explanation of this. The glomerular filtration rates also have been measured by estimating the inulin clearances of a few babies. These too are low, judged by adult standards, and vary with the state of the infant's hydration. For these reasons any infant short of water is likely to have renal failure and one who is fed on cow's milk suffers sooner than a breast-fed baby, because his food contains more protein and salt.

An infant needs extra water whenever the output by the skin, lungs or bowel is increased, because his urine volumes must not be allowed to fall. Water should be given if a baby is feverish, but salt must be given as well if he is suffering from diarrhoea and vomiting. The objects of treatment are to restore the volume and the normal composition of the body fluids. The only electrolyte needed is sodium chloride for the others are supplied by the processes of metabolism. Since the gastro-intestinal secretions may be regarded as isotonic, the amount of salt lost in them corresponds to the amount that would have been contained in an equivalent volume of 0.9% NaCl. A hypotonic solution of salt should, however, always be given to an infant with gastro-enteritis unless he is taking water by mouth because water, but not salt, is excreted by the skin and lungs. If fluids are to be given by the intravenous route and 0.9% NaCl and 5% glucose solution are available for the infusion, the proportion of each in the volume of fluid to be given can be varied according to the needs of the patient.

If the dehydration has been mild we have given, without waste of time, a solution of glucose and salt up to 3% of the body-weight, and, if severe, up to 6% or 7% of the body-weight. The solution has generally been a mixture of 0.9% NaCl and 5% glucose in equal parts. This was followed by a maintenance infusion of one part of 0.9% NaCl to four parts of 5% glucose to supply the normal daily requirement (2 to 2½ oz. per lb. body-weight). If the diarrhoea has been very profuse, it has sometimes been necessary to give more of the 0.9% solution of NaCl.

In order to enable the body to regulate the pattern of its mineral composition, enough water must be given to establish a free flow of urine and both the dehydration and the oliguria should be relieved within a few hours. It is sometimes possible to do this in

**Changes in the ligaments.**—In a number of cases with persistent severe pain in the back, while in the first series of radiographs the spine appeared to be normal, subsequent radiographs one and more years afterwards showed a slowly progressive ossification at the ligamentous insertions into the vertebral bodies. In a number of these, manipulations have proved unsatisfactory and, compared with some cases which had been treated more conservatively, appeared to show more extensive ligamentous ossification. The condition progresses with increased ossification on the concave aspects of the curvatures. Radiographic evidence does not entirely support the view that these ossifications in the ligaments are secondary to arthritic changes in the articulations, but bony ankylosis of all the articulations may be present without any appreciable changes in the ligaments and changes in the ligaments may be present without evidence of arthritis. In some cases localized ossification of the ligaments may be the only radiographic evidence of trauma which occurred a year or so previously—earlier radiographs giving no indication of the site of the damage.

**The linear thoracic paraspinal shadow.**—Under this title an editorial in *Radiology*, August 1942, draws attention to "a slender line of demarcation which is often seen in antero-posterior or sagittal roentgenograms of the bony thorax and upper abdomen. This line lies on the left side of the lower two-thirds of the thoracic spine and sometimes continues as far down as the plane of the first two lumbar segments." This is a most useful radiological sign. It is undoubtedly due not to dense structures or the hemiazygos vein, but to the medial border of the lung and its inferior extremity will be seen to coincide with the medial inferior border of the diaphragm. Though it is chiefly shown on the left side because the descending aorta limits the medial boundary of the lung on that side, it is frequently seen on both sides.

Though the descending aorta appears to account for its more common demonstration on the left side the line does not coincide with the left lateral border of the descending aorta which can often be seen lateral to the medial border of the lung. This will be appreciated from an examination of the line drawing of a transverse section of the body. The importance of this line lies in the fact that it is deviated laterally by any lesion causing expansion of the tissues surrounding the dorsal vertebral bodies. The commonest of these is the paravertebral tuberculous abscess which shows as a fusiform expansion of variable length and width in association with a localized tuberculous caries. The abscess may be recognizable before there is any demonstrable bony change. Vertebra plana in its initial stages shows a localized paravertebral expansion suggesting abscess formation but it is not associated with diminution of the disc space. Crushed vertebral bodies show bilateral deviation of this line and if due to neoplasm the greater deviation of the line may lead to the mistake of diagnosing tuberculous caries, though the usual sparing of the disc in neoplasm should guide the decision. In a case which came to court the presence of a crush fracture of the vertebral body was disputed until the presence of a paravertebral hematoma resembling a tuberculous abscess was demonstrated on the radiograph taken immediately after the accident and its absence in radiographs taken a fortnight after.

In osteochondritis of the dorsal spine the line can be demonstrated on both sides. In certain other inflammatory and neoplastic conditions involving the anterior common ligament the line may be recognized on both sides sometimes as much as  $\frac{1}{2}$  in. lateral to the borders of the vertebral bodies.

In the abdomen inflammatory lesions of the spine may be indicated by deviation of the line of the psoas muscle before bone changes are distinguishable.

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Dr. Avery Jones suggested that clinicians were lulled into a sense of false security by the name normal or physiological saline and therefore did not worry about giving large amounts to sick children. It had been shown conclusively that adult post-operative cases could be given a great excess of salt by the routine use of normal saline and this caused water retention with hydræmia and a tendency to œdema of the lungs or of the intestinal suture line.

Many sick infants received at least 12 g. of salt, an amount equal to the total salt content of the body of an infant and equivalent to  $3\frac{1}{2}$  oz. of salt for an adult. Dr. Young had shown clearly that the infant's kidney was quite unable to deal with such amounts and therefore the infants tended to become œdematous with salt-bound water and yet had no water available for the normal losses from skin and lungs.

He wondered whether sufficient attention was paid to the vitamin B complex in such children for it had been stressed recently that there was a quantitative relation between the glucose and the vitamin B requirements. If a deficiency existed the infants could develop a condition equivalent to an acute beri-beri. He would like to know whether others had had success with the use of tibial marrow transfusions and said it had proved satisfactory in five out of six infants he had recently treated.

Dr. Richard Dobbs: This discussion serves to show to what a large extent practising pædiatricians are ignorant of the very important biochemical and physiological changes which manifest themselves to them as "dehydration", "shock" and "collapse" in infants suffering from acute gastro-enteritis. The important questions are firstly, what is the most useful, or, rather, the least dangerous fluid to use, and what is the most valuable route? From clinical experience it seems that the oral route may be unsatisfactory because of vomiting or because the fluid may not be absorbed, and that the intravenous route has its dangers. The subcutaneous route is undoubtedly the safest, and by it saline or any other electrolytic solution is satisfactorily absorbed. I would like to stress that though it is probably the most satisfactory for experimental purposes, the intravenous route is dangerous unless more care and constant attention are available from both nursing and medical staff than is usually the case. Vascular and right heart failure, and cerebral pulmonary œdema follow on too much or wrong fluid very much more easily with intravenous than with other routes of administration.

[December 8, 1942]

## The Ætiology of Erythroblastosis Fœtalis and Certain Hæmolytic Transfusion Reactions, with Special Reference to the Rh Factor

By P. L. MOLLISON, M.B., M.R.C.P.

For a long time it has been recognized that the clinical conditions known respectively as hydrops fœtalis and icterus gravis neonatorum are closely related and, since the publication of Diamond, Blackfan and Baty's paper in 1932, it has been realized that so-called congenital anæmia of the newborn is a further manifestation of the same disease process. Although the relationship between these different syndromes has been generally recognized and the clinical and pathological features of each one fully described, there has been very incomplete understanding of their ætiology.

Diamond and his co-workers pointed out that extramedullary hæmatopoiesis occurred in all three conditions. They accordingly revived an old term "erythroblastosis" to describe all three syndromes and to give prominence to their belief that abnormal hæmatopoiesis was the primary disorder.

This view was challenged by Parsons, Hawksley and Gittins (1933) who considered that a hæmolytic process affecting the red cells, or rather the whole erythron, was the primary feature and that the erythroblastosis was merely a response to this destruction. The rapid fall in blood-count after transfusion observed in some cases of icterus gravis neonatorum by Hawksley and Lightwood (1934) was cited by them as further evidence in favour of the hæmolytic theory.

Although the view that these syndromes are characterized by hæmolysis was widely accepted in this country, there was a complete ignorance of the cause of the hæmolysis. In 1941, however, Levine and his co-workers demonstrated that the cause lay in iso-immunization of the mother during pregnancy. They showed that the recently discovered Rh agglutininogen was intimately concerned with this process in the majority of instances.

an infant who is not vomiting by giving him fluids by mouth, but his salt requirement needs to be assessed just as carefully as if fluids are being given parenterally. The rectal route is only useful as a method of supplementing the oral intake, if a patient is vomiting but has no diarrhoea. A larger volume of fluid can be given by the subcutaneous route, but it also should only be used as a supplement to oral feeding because the solution to be given is isotonic (0.9%) NaCl. Glucose solutions should not be used on account of the danger of abscess formation. The intravenous route is frequently the only one by which the depleted body fluids can be restored sufficiently quickly. Moreover, if the infusion is efficiently given, it is the most comfortable procedure for the patient. Continuous drip infusions and infusions at four to six hourly intervals as a supplement to oral feeding have both been used. Whichever route is chosen accurate charting of the output is essential in order to estimate the day-to-day requirements. Daily weighing of the patient is very helpful. The change in weight is a much more sensitive indication of the water balance than estimations of the serum chemistry. There are dangers in giving too much salt and in giving too little. If more is given than is excreted either the concentration in the body fluids increases or oedema fluid is formed; both prejudice recovery. It is not possible to relieve dehydration associated with salt deficiency without giving enough salt, and if large volumes of glucose solution are given, there is a risk of water poisoning.

The difficulties of treating infants who are suffering from gastro-enteritis are due to: (1) the persistence of vomiting and diarrhoea, and (2) the complications, e.g. stomatitis. Nevertheless, if an infant can be kept in water and salt balance for a few days, it is surprising how often he gets better, while if he is allowed to become dehydrated a second time the prognosis is invariably worse. An acute infection is more dangerous to a baby than to an adult, but if he recovers, he suffers from no permanent disability. Detailed medical and nursing care are necessary in order to regulate his water metabolism while he is sick, but he may pass from extreme dehydration to perfect health in the course of a few days.

**Dr. R. A. McCance: Salt deficiency and dehydration.**—There is a very great difference between true dehydration, that is to say a loss, or a deficiency, of body water, and a state of salt deficiency, which is usually brought about by a loss of water and salt with partial or total replacement of the water. This distinction was first brought out by Kerpel-Fronius (1935) and it has been elaborated by Nadal *et al.* (1941). I can perhaps illustrate the difference most forcibly by my own personal experiences. When I made myself salt deficient in 1935, I only managed to lose about 6 lb. of weight, but my plasma proteins rose from 7.2 to 8.2 g. per 100 c.c. and my hæmoglobin from 13.8 to 17.4 g. per 100 c.c. so that there was clear evidence of severe hæmoconcentration. This was accompanied by the signs and symptoms of a diminished blood volume. I was unable to take any exercise without breathlessness and slight anginal pain, and I know from my experiments on other people that my glomerular filtration rate undoubtedly fell. The amount of sodium in my serum was below its normal level and I had cramps.

When I dehydrated myself early this year, I lost practically 10 lb. of weight without any difficulty at all. My serum sodium rose to abnormal levels, but there were no changes in my plasma proteins or hæmoglobin. I suffered no reduction in my blood volume and in consequence there was no fall in my glomerular filtration rate and I was able to take exercise with fair comfort in spite of my loss of weight. In both experiments my intake of food was sufficient for my needs so that loss of weight on account of starvation may be excluded.

In clinical medicine, true dehydration is not often met with in temperate climates, except perhaps after surgical operations involving the gastro-intestinal tract, in high fever, particularly in infancy, and during the first few days of life. It is unfortunately common enough to-day during lifeboat voyages and after forced landings in the desert. We usually have to deal clinically with a loss of salt as well as water, for this is the fate of patients with vomiting or diarrhoea, and of patients with diabetic coma and Addison's disease (McCance, 1936). All such should be given salt as well as water, but after the body-weight has been restored by saline solutions it is better to switch over to 5% glucose for intravenous infusion unless salt is still being lost. The administration of glucose solutions provides water for the losses by the lungs and skin without overburdening the kidneys with salt (Jones and Morgan, 1938).

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be far more common. The two most obvious factors to consider are failure of the Rh antigen to cross the placenta in adequate amount to stimulate the formation of anti-Rh agglutinins and failure of the mother to respond to the stimulus. The latter factor probably plays a big part; irregularity of response between one subject and another is a familiar feature of immune responses as a whole. We have observed cases in which an Rh negative mother bears several Rh positive children without incident and in any case, as has long been recognized, the first child in families in which erythroblastosis occurs is usually unaffected. We have often found that these first children are Rh positive.

The value of serological tests in erythroblastosis foetalis may be summarized as follows:

(1) In doubtful cases the diagnosis is strongly supported when the mother is found to be Rh negative and the infant Rh positive and anti-Rh agglutinins are found in the mother's serum.

(2) In doubtful cases the diagnosis of erythroblastosis foetalis is virtually excluded when the infant's erythrocytes are found to contain no agglutininogen which the mother's erythrocytes lack and when the mother's serum is found to contain no agglutinin that is incompatible with the infant's erythrocytes. In making tests for atypical agglutinins in the mother's serum it must be remembered that these agglutinins are immune bodies and that their potency increases after delivery (Boorman, Dodd and Mollison) and then decreases again. Unless the serum is examined repeatedly the agglutinin may be missed.

(3) Serological tests can be used to select suitable donors for the transfusion of the infant. Because Rh positive blood is usually rapidly destroyed by the infant, the father's blood is unsuitable. Although the mother's cells, being Rh negative, will survive well after transfusion in the infant's circulation, her serum contains anti-Rh agglutinins and a different (unimmunized) Rh negative person is therefore preferable as a donor.

While recommending the use of Rh negative donors for transfusion to cases of hæmolytic anæmia of the newborn, it must be realized that these cases demand early and adequate transfusion. The diagnosis is not always made very promptly, and treatment is not as a rule begun as early as it might be. Apart from improving the immediate survival, the transfusion of Rh negative blood, particularly when carried out early, may be found to lower the incidence of damage to the central nervous system.

Of 27 cases of proved icterus gravis neonatorum seen during the last nine months, 17 recovered. Transfusions, mainly of 150 to 200 c.c. of Rh negative blood (administered at 8 to 12 drops a minute via the internal saphenous vein), almost certainly played a part in this good recovery rate, for whereas none of the ten who died had received a transfusion, all of those who recovered had been transfused. Nevertheless, these figures somewhat slightly exaggerate the value of transfusion because the milder cases tend to be transfused and many of these would recover without transfusion whereas many of the more serious cases, which transfusion might not save, die within a few days of birth before the transfusion is arranged.

An effect of iso-immunization that is of very great importance is the sensitization of the mother towards a transfusion of Rh positive blood. If the mother's serum contains anti-Rh agglutinins, Rh positive blood will be incompatible. Rh agglutination cannot be satisfactorily detected by the ordinary slide test, so that the blood is likely to appear perfectly compatible unless a special method of direct matching is used. Nevertheless, in such cases the results of transfusion may be as disastrous as those of an incompatible transfusion due to faulty A-B-O grouping. The connexion between erythroblastosis in the infant and hæmolytic transfusion reactions in the mother (see Burnham, 1941) is so important that it seems worth emphasizing by a detailed description of two case histories.

CASE I.—First pregnancy normal but in the second pregnancy she developed a toxæmia and gave birth to a stillborn foetus. In the third pregnancy a very severe toxæmia developed and an infant affected with hydrops foetalis was born. Because of the history of bad toxæmias the fourth pregnancy was terminated at the third month. Following operation a transfusion of group O blood was given. The patient developed backache, suppression of urine and jaundice. The blood urea rose progressively and reached a figure of 400 mg.% on the fifteenth day; thereafter, recovery was uneventful. Investigations showed that the patient was group O Rh negative and that her serum contained anti-Rh agglutinins. Her husband was group O Rh positive, and the donor was also group O Rh positive.

CASE II.—First two pregnancies normal. The third pregnancy ended in a miscarriage at five months; this was thought at the time to be due to a fall. The fourth child developed the classical features of hæmolytic anæmia of the newborn. The fifth pregnancy proceeded normally but bleeding, due to placenta prævia, developed when the patient went into labour. A transfusion was given and was followed by a rigor. A very pale dead infant was delivered. On the following day the patient became jaundiced and passed very little urine.



Landsteiner and Wiener demonstrated in 1941 that the red cells usually contain an agglutinin which they termed Rh because a similar agglutinin is present in the red cells of rhesus monkeys. They showed that this agglutinin is distributed amongst different persons irrespective of their A-B-O group and that amongst American whites only about 15% of persons lack the agglutinin.

Wiener and Peters (1940) showed that this 15% of persons (Rh negative) whose erythrocytes lack the Rh agglutinin may develop specific anti-Rh agglutinins if they are transfused with blood containing the Rh agglutinin (Rh positive).

Levine, Katzin and Burnham (1941) showed that anti-Rh agglutinins may also be found in the sera of Rh negative women in connexion with pregnancy and they recalled Levine and Stetson's speculation that some agglutinin contained in the foetus might cause the development of atypical iso-agglutinins in the mother's serum during pregnancy. In a paper published in 1941, they showed that the presence of these atypical agglutinins in the mother's serum is often associated with foetal morbidity, and particularly with erythroblastosis foetalis. They suggested that the atypical agglutinins in the mother's serum pass back across the placenta into the foetal circulation and cause the destruction of the foetal erythrocytes. In a later paper (Levine, Burnham, Katzin and Vogel, 1941) it was shown that the Rh agglutinin is involved in the majority of instances. This was demonstrated by testing a series of mothers and infants and showing that over 90% of the mothers were Rh negative compared with 15% in a random sample of the population. Similar findings have been reported by Boorman, Dodd and Mollison (1942). In both these series, all the infants examined were Rh positive. These findings alone strongly suggest that iso-immunization of the mother to the Rh agglutinin is intimately connected with affection of the foetus, since only Rh negative persons can produce anti-Rh agglutinins. The actual finding of immune agglutinins in the sera of mothers is further evidence. Such agglutinins were found by Levine and his co-workers in approximately one-third of their cases and by Boorman, Dodd and Mollison in over 90%. The difference between the two series is probably to be accounted for partly by the more favourable time of examination (i.e. shortly after delivery) in a greater proportion of cases in the latter series, and partly by differences in technique. The evidence then is that in the majority of cases the Rh agglutinin is involved and the destruction of the foetal erythrocytes is due to the passage of immune anti-Rh agglutinins from the maternal into the foetal circulation.

Where the destruction of the foetal erythrocytes is thought to be due to anti-Rh agglutinins, further evidence can be obtained by demonstrating that Rh positive erythrocytes are rapidly destroyed in the foetal circulation whereas Rh negative erythrocytes survive for long periods. This can be done by transfusing a mixture of Rh positive and Rh negative blood to such an infant and then estimating quantitatively, by an elaboration of the differential agglutination technique, the survival of the two types of blood in the recipient's circulation. In all except one of the cases studied so far, Rh negative blood has been found to survive for ninety days or more, whereas Rh positive blood has often been destroyed within a few days of transfusion (unpublished data). These observations provide very strong support for Levine's theory and at the same time indicate that the infant should be transfused with Rh negative blood whenever possible.

While the knowledge of the pathology of the group of conditions hitherto known as erythroblastosis foetalis is by no means complete, all future theories will have to take as their central feature haemolysis due to immune iso-agglutinins.

The cases in which the mother is Rh positive and therefore can form no anti-Rh agglutinins present an interesting problem. Elsewhere we have presented our reasons for believing that the ordinary agglutinins anti-A and anti-B may sometimes be responsible, and evidence obtained recently has confirmed this view. Possibly, as has been suggested by Levine, Burnham, Katzin and Vogel, failure of the tissues to secrete the group specific substances A and B may lay the way open for attack upon the erythrocytes.

Other antigens besides Rh, A and B may prove to be responsible in rare cases. The essential thing from the serological point of view is the demonstration that the foetal erythrocytes contain an antigen that the mother lacks. In the majority of cases it should be possible to show in addition that the maternal serum is incompatible with the foetal erythrocytes, although this may be made impossible by the disappearance of the immune agglutinins from the mother's serum within a short time after delivery. Thus, the mother's serum as well as the mother's cells must be examined and the infant's cells must be tested or, if the infant is dead, the father's cells. In testing the latter, the mode of inheritance of the Rh factor must be borne in mind.

Since in approximately 1 in 10 pregnancies the mother is Rh negative and the infant Rh positive, other factors have to be considered, for otherwise erythroblastosis foetalis would

licable at present because of the small percentage of Rh negative persons in the population.

However, the great majority of transfusion accidents due to the Rh factor would be avoided if mothers of infants affected with erythroblastosis were not transfused except with Rh negative blood and if persons who have responded unfavourably to transfusion were not retransfused until the cause of the unfavourable reaction had been ascertained. In cases of urgency, plasma or serum should be used instead of whole blood.

I should like to acknowledge the kindness of those clinicians and pathologists who have allowed me access to cases under their care and also the help of Miss Boorman and Miss Dodd who carried out many of the serological tests in the cases reported here.

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### Tests for the Rh Factor and its Antibody

By G. L. TAYLOR (*working on behalf of the Medical Research Council*)

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THE presence of Rh antigen is detected by the red cells containing it being agglutinated when mixed with serum in which is the corresponding anti-Rh agglutinin. There are two sources of grouping sera. (1) Animal: serum of a rabbit or guinea-pig injected with the red cells of the Rhesus monkey. The preparation and use of animal sera for detecting Rh is difficult. (2) Human: anti-Rh may be found in mothers of erythroblastic babies and in persons who have had hæmolytic transfusion reactions due to Rh. Few human anti-Rh sera are strong enough to be used as reagents. Some Rh-positive cells react very weakly and unless a good serum is used they may be recorded as negative. False negatives are the great bugbear in Rh work. Human sera will probably prove the most convenient reagents and I think most of them will come from mothers of erythroblastic babies.

*Detecting anti-Rh.*—Serum is heated for fifteen minutes at 56° C., as Wiener recommends, for some sera before heating fail to react properly with some Rh-positive cells. The serum is mixed with cells from at least two strongly positive donors, with negative cells and with cells from the donor of the serum; some sera agglutinate their own cells and this is a necessary control. Known positive and negative cells should be of group O to avoid the possibility of reactions due to the A-B-O system of groups. Most grouping is done on a slide, tile or plate, but for Rh work tubes must be used. Ours are 2 in. long by ¼ in. diam. and in them we make series of falling dilutions of serum. In the first tube the serum is undiluted; in the second diluted 1:2; in the third 1:4 and so on for 6 or 7 tubes. Into every tube except the first we place a volume of physiological saline solution; the first receives a volume of undiluted serum. With the saline in tube 2 we mix a volume of serum getting two volumes of 1:2, one of which we add to tube 3 getting two volumes of 1:4 and continue this doubling up until every tube gets its dilution. One of the two volumes in the last tube is discarded. To each tube we add a volume of red cell suspension (1 to 2% whole blood) of a strongly positive donor. Cells and serum are mixed by picking up a tube and flicking with the finger and on each tube is placed a glass cap to prevent evaporation and serve as place-marker in reading tests. To other identical series are added cells from a second strongly positive person, negative cells and the cells of the donor of the serum. If the donor is the mother of an erythroblastic baby, and if the A-B-O groups permit, and if we have the cells, we also titrate the serum with cells from the baby and the father. The tests are stored at room temperature and an identical set in the incubator at 37° C. Some human anti-Rh sera work better at room, others at body temperature. The great majority are better at body than at room temperature.

Investigations carried out five days after transfusion showed that the patient was group A Rh negative and that her serum contained weak anti-Rh agglutinins. Her husband was found to be group B Rh positive and the donor group O Rh positive. No group O blood was found to be surviving in the recipient's circulation.

Ten days after the first transfusion, group O Rh negative blood was given with a satisfactory result. Tests made after transfusion showed that this blood was surviving normally in the recipient's circulation.

Though it is known that women who give birth to infants affected with erythroblastosis also have an increased incidence of stillbirths, yet, as Henderson (1942) has emphasized, the pathology of these cases has been neglected. Now that the danger of hæmolytic transfusion reactions in women whose infants are affected with erythroblastosis is recognized, it becomes extremely important to emphasize this fourth type of erythroblastosis *fœtalis*, as Henderson has called it. The following cases illustrate the occurrence of "unexplained" stillbirths and cases of erythroblastosis *fœtalis* in the same family.

CASE III.—The first child was born three weeks before term but exhibited no abnormality. During the following nine years the patient gave birth to six stillborn infants after pregnancies lasting between six and eight months. Six years later, the eighth pregnancy resulted in the birth of an infant affected with icterus gravis neonatorum. The woman was group A Rh negative, her serum contained anti-Rh agglutinins and the infant was group A Rh positive.

CASE IV.—First child normal, second died of jaundice twenty-four hours after delivery. Third pregnancy ended prematurely in the birth of a macerated but otherwise normal *fœtus*. The mother was group A Rh negative and her serum contained anti-Rh agglutinins.

CASE V.—First infant normal, second infant stillborn, third died within twenty-four hours after delivery. The second and third infants were outwardly normal. The fourth infant developed typical hæmolytic anaemia of the newborn. The mother was group O Rh negative and her serum contained anti-Rh agglutinins; the infant was group O Rh positive.

In discussing the possible manifestations of erythroblastosis *fœtalis* it should be added that it is occasionally difficult to distinguish between mild cases of icterus gravis and severe cases of "physiological jaundice" of the newborn. The possibility of the infant having erythroblastosis should be considered whenever there is any *fœtal* or neonatal morbidity for which there is no other obvious cause. Suspecting the infant of having erythroblastosis implies suspecting the mother of having become sensitized to the Rh agglutinin and therefore avoiding transfusion unless known Rh negative blood of suitable A-B-O group is available.

Iso-immunization to the Rh agglutinin may occur apart from pregnancy in Rh negative persons of either sex, that is as a result of the transfusion of Rh positive blood (as mentioned above). In such cases, the response to a first transfusion may be satisfactory but the response to subsequent transfusions becomes increasingly unfavourable. The signs to look for are a failure of the recipient's hæmoglobin concentration to increase following transfusion (the concentration may increase temporarily but then fall within a few days), the development of jaundice after transfusion and the development of more severe signs of hæmolysis such as hæmoglobinuria.

The possibility that iso-immunization produced by transfusion may affect the mother's response to a subsequent pregnancy should be borne in mind. Whereas an Rh negative woman usually fails to produce anti-Rh agglutinins during her first pregnancy with an Rh positive infant, if she has had a previous Rh positive transfusion she may have been sensitized and thus produce anti-Rh agglutinins during her first pregnancy and give birth to an affected infant instead of a normal one.

CASE VI.—The patient became an air-raid casualty in November 1940 and was transfused with 1,000 c.c. of blood. She left hospital, but six months later was admitted to another hospital for plastic operations. After one of these operations she had a three months' miscarriage. In 1942, she gave birth to an infant which died after a few days from icterus gravis. The serological findings were typical of iso-immunization to the Rh agglutinin.

Of course in this case the early miscarriage may have been the "immunizing pregnancy", but it was a very brief pregnancy and it seems equally likely that the transfusion was responsible for the brisk immune response to the first "full" pregnancy.

Clearly, transfusion reactions due to the Rh agglutinin could be completely avoided if Rh negative persons were never transfused with Rh positive blood and at the same time the possibility envisaged in Case VI would never arise. At present, however, it seems quite impracticable to suggest that every potential recipient of a transfusion should have his or her Rh group determined. The alternative procedure of supplying Rh negative blood on a large scale or even for maternity cases alone, must also be considered imprac-

licable at present because of the small percentage of Rh negative persons in the population.

However, the great majority of transfusion accidents due to the Rh factor would be avoided if mothers of infants affected with erythroblastosis were not transfused except with Rh negative blood and if persons who have responded unfavourably to transfusion were not retransfused until the cause of the unfavourable reaction had been ascertained. In cases of urgency, plasma or serum should be used instead of whole blood.

I should like to acknowledge the kindness of those clinicians and pathologists who have allowed me access to cases under their care and also the help of Miss Boorman and Miss Dodd who carried out many of the serological tests in the cases reported here.

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### Tests for the Rh Factor and its Antibody

By G. L. TAYLOR (*working on behalf of the Medical Research Council*)

*Galton Laboratory Serum Unit, at the Department of Pathology, Cambridge*

The presence of Rh antigen is detected by the red cells containing it being agglutinated when mixed with serum in which is the corresponding anti-Rh agglutinin. There are two sources of grouping sera. (1) Animal: serum of a rabbit or guinea-pig injected with the red cells of the Rhesus monkey. The preparation and use of animal sera for detecting Rh is difficult. (2) Human: anti-Rh may be found in mothers of erythroblastic babies and in persons who have had hæmolytic transfusion reactions due to Rh. Few human anti-Rh sera are strong enough to be used as reagents. Some Rh-positive cells react very weakly and unless a good serum is used they may be recorded as negative. False negatives are the great bugbear in Rh work. Human sera will probably prove the most convenient reagents and I think most of them will come from mothers of erythroblastic babies.

*Detecting anti-Rh.*—Serum is heated for fifteen minutes at 56° C., as Wiener recommends, for some sera before heating fail to react properly with some Rh-positive cells. The serum is mixed with cells from at least two strongly positive donors, with negative cells and with cells from the donor of the serum; some sera agglutinate their own cells and this is a necessary control. Known positive and negative cells should be of group O to avoid the possibility of reactions due to the A-B-O system of groups. Most grouping is done on a slide, tile or plate, but for Rh work tubes must be used. Ours are 2 in. long by 1/4 in. diam. and in them we make series of falling dilutions of serum. In the first tube the serum is undiluted; in the second diluted 1:2; in the third 1:4 and so on for 6 or 7 tubes. Into every tube except the first we place a volume of physiological saline solution; the first receives a volume of undiluted serum. With the saline in tube 2 we mix a volume of serum getting two volumes of 1:2, one of which we add to tube 3 getting two volumes of 1:4 and continue this doubling up until every tube gets its dilution. One of the two volumes in the last tube is discarded. To each tube we add a volume of red cell suspension (1 to 2% whole blood) of a strongly positive donor. Cells and serum are mixed by picking up a tube and flicking with the finger and on each tube is placed a glass cap to prevent evaporation and serve as place-marker in reading tests. To other identical series are added cells from a second strongly positive person, negative cells and the cells of the donor of the serum. If the donor is the mother of an erythroblastic baby, and if the A-B-O groups permit, and if we have the cells, we also titrate the serum with cells from the baby and the father. The tests are stored at room temperature and an identical set in the incubator at 37° C. Some human anti-Rh sera work better at room. others at body temperature. The great majority are better at body than at room temperature.

After an hour, or better after two, the tests are read. The character of the sediment at the bottom of the tube gives a good idea as to whether there is clumping or not. The cap is removed and the sediment examined with a hand lens, but the final diagnosis is based on microscopic examination. The greatest care and gentleness are needed in transferring some of the sediment to a microscope slide; any roughness may undo some of the more weakly positive reactions and a false negative may be recorded. Good reactions are easily seen; weakly reacting cells may cause trouble. In sedimenting, cells aggregate, and a beginner may mistake for true agglutination a lumpy drift of cells; such a drift gradually breaks up.

Some set up only the top tubes of a series but we prefer to titrate, because: (1) Titration indicates the strength of any antibody present. (2) We have found a serum which, undiluted, failed to react with some positive cells, but which, in titration, gave definite reactions in some dilutions. Without titration incompatibility between such a serum and the cells of intended donors might be missed.

When tests suggest that anti-Rh is present we mix the serum with positive cells from four or five other donors and with one or two lots of negative cells, and if it reacts with all or nearly all the positives and not with any negatives, it seems certain that anti-Rh is present, and indeed when all the positives react and the negatives fail to, a simple sum gives exactly the odds that the serum contains anti-Rh. I advise this titration technique in direct compatibility tests between recipient's serum and potential donors' cells, and I would not use any donor whose cells gave the slightest sign of a reaction.

With good sera red cells can be grouped for Rh by methods similar to those described. Titration is not needed and a serum which required titration would not be used. A volume of serum is mixed with a volume of red cells and to avoid any tendency a serum may have to give false agglutination, a volume of saline is added. Tests are stored at room or incubator temperature according to which is better for the sera in use. Bringing together antibodies and antigens of the A-B-O groups should be avoided otherwise the Rh grouping cannot be done. Anti-A or anti-B in a serum can be absorbed by mixture with appropriate cells, e.g. A Rh-negative cells will remove anti-A and leave anti-Rh. Mixing the serum with the saliva of a person who secretes the appropriate antigen will also remove the A-B-O antibodies. About 80% of people secrete in the saliva the A-B-O antigens present in their red cells. With a supply of Rh sera from all the four blood groups a worker need not absorb, he can choose those appropriate for the cells he is testing.

No cells should be diagnosed as negative unless they have been tested with at least three strong anti-Rh sera. Some sera react well with all but a few Rh-positive cells. One may react well with the cells of x and poorly or not at all with those of y, whilst another does well with y and badly with x. If a serum tends to give slight false positive reactions, reference to the reactions given by other sera will help diagnosis.

Rh testing is tricky and needs considerable experience, but it will become less of an art and more of a science when we get good supplies of really strong sera, and for these we must look to the clinicians who are in charge of the mothers of erythroblastic babies.

My unit has examined blood from 49 mothers of erythroblastic babies; 43 were Rh-negative, and in the sera of 37 of these 43 we found anti-Rh. In a random sample of 49 women only 7 or 8 would be expected to be Rh-negative; we found 43. There can be no doubt that the Rh factor plays an essential part in the causation of most cases of erythroblastosis foetalis.

## Section of Epidemiology and State Medicine

President—E. H. R. HARRIES, M.D.

[January 22, 1943]

### Some Aspects of the Epidemiology of Smallpox in Scotland in 1942 (*Abridged*)

By IAN N. SUTHERLAND, M.B., M.R.C.P.Ed., D.P.H.

*Historical.*—The description of the epidemiology of smallpox in Scotland in 1942 may be helped by a short reference to history. Some data on the disease and on infantile vaccination have been assembled in Table I.<sup>1</sup> Outstanding in this table are the epidemic of major smallpox in Scotland, especially in Glasgow, during 1920 to 1921 (causing 176 deaths), and the epidemic of minor smallpox in Dundee in 1927 to 1928, not causing any deaths in these years. Full reports of these epidemics have been published (Macgregor, 1921; Burgess, 1928). Both epidemics were prolonged and included large numbers of cases. Apart from the high fatality rate in unvaccinated infants, the fatality rates in each age-group over 1 year were remarkably constant. The proportion of deaths in age-groups by vaccinal states showed mainly deaths of vaccinated persons under the age of 15 and mainly deaths of unvaccinated persons over the age of 15.

During the period 1918 to 1939 the percentage of children successfully vaccinated fell with considerable regularity from a peak of 70.5 in 1920 to a trough of 42.2 in 1938. It is clear that, unless there was a high proportion of vaccinations in later life, of which there is no evidence, the majority of the child population, and the great majority of those beyond childhood, were unprotected by vaccination.

*The Glasgow outbreak.*—On this background is set the arrival at Glasgow on May 29 of a ship with a case of major smallpox on board. The subsequent history of Glasgow has been fully described elsewhere (Macgregor and Peters, 1942). There is some mystery of the source of infection of this first case. The most probable possibilities are that he was infected (a) ashore in Capetown, (b) on board from a "missed" case, or (c) on board by fomites.

In the Glasgow outbreak, one sees in Glasgow 11 ship cases, 21 untraceable cases in the general population, and four cases in contacts. The untraceable cases deserve further mention. They were not scattered throughout the whole city area. The west and a large part of the south were free. The dock area did not show a high incidence. The untraceable cases, charted by dates of rash, show a wave centred on July 26 and 27, preceded by a broad wave of secondary ship cases which centred roughly on July 10. Following the main wave of untraceable cases there were three—possibly four—more cases in this category. Included in the untraceable cases were persons who had, because of age or other reasons, little contact with the outside world and whose chance of acquiring a prevalent infection would be thought much less than those of younger persons or persons taking a more active part in the life of the community; but also there were cases such as that of a tram conductress who worked on the first day of her sickening and to whom no secondary case could be traced. During the period of probable infection of most of the untraceable cases, there was no general vaccination campaign. The age and sex distribution of the cases will be given later. Meantime, it may suffice to note that the range of ages in the untraceable group was from 12 to 72. The last of the group of

<sup>1</sup> Not reproduced; see References.

untraceable cases was a patient in a mental institution. The report on the Glasgow outbreak has included a description of his environment.

The social incidence was mainly on working-class occupations. Of the patients in general, one derived the impressions that smallpox had affected those whom one would have expected to escape, and that those whom one would have expected to have a selectively high incidence escaped infection.

*The Fife outbreak.*—The last Glasgow case developed his rash on July 31. There was a long pause until it was discovered early in October that smallpox had been occurring in Methilhill, Fife. The Fife outbreak apparently started with an original patient whose rash appeared on August 21, twenty-one days after the development of the rash in the last Glasgow patient—a secondary case in a closed population. Twenty-six subsequent cases in Fife were traceable to the original case or her secondary or derived cases. The genealogical tree of this outbreak (Chart I, p. 14) demonstrates the tendency to death associated with an infection through Cases 4 and 5. Of 15 cases derived from Cases 4 and 5 (which were both fatal), six died. Of eight cases not so derived, none died. If the deaths of Cases 4 and 5 are included with those of their derived cases, the observed distribution is consistent with an increase in the inherent severity of the disease before passing through Cases 4 and 5 ( $\chi^2=5.54$ ,  $P$  about 0.02). If the deaths of Cases 4 and 5 are excluded, which may be considered equivalent to postulating an exaltation of virulence after the disease had infected these two patients, the tendency towards death in their derived cases still remains significant ( $\chi^2=4.33$ ,  $P$  about 0.04). This very interesting question was first raised by Dr. Fyfe who observed the selective nature of the mortality in the group of patients who had been infected through contact with Cases 4 and 5.

A general vaccination campaign in the district was started on October 8 and achieved a high acceptance rate. The outbreak had been limited geographically, and the rash of the last case of this group appeared on October 19. Two further cases occurred in November. One was in Cowdenbeath, 13 miles from Methilhill, the other near Thornton, four miles from Methilhill. The Cowdenbeath case was untraceable. Dr. Fyfe has made the following comment on the Thornton case:

"The infection of this man is of interest. His rash appeared on November 13. On October 28 he was in the wood surrounding the Smallpox Hospital, in which patients exercise. He saw some of the patients and probably spoke to them. Was he thereby infected? As an alternative source, it is known that the Hospital chauffeur, who resides in a building adjoining the Smallpox Hospital, calls at the patient's house for his newspaper. Did he convey infection from the hospital to the house? Such is possible, although the chauffeur is well drilled in precautionary measures."

While the Thornton patient has been entered in the tables as untraceable, the adjective probably applies only to the means of conveyance of the infection.

An incident which occurred during the Fife outbreak showed that the danger of widespread transference of smallpox is always present. A coastal ship was at Methil on October 14 and 15 and arrived at a port in Northern Ireland at the end of October. One of the crew, who had been ashore while at Methil and who had not accepted vaccination before returning to the ship, developed a rash on October 28 and was found to be suffering from smallpox.

The social incidence in Fife was not selective. No connexion has ever been proved between the Glasgow and Fife outbreaks, though probably it did exist.

*The Edinburgh outbreak.*—Eight days after the last of the Fife contact cases (judging by appearance of rash) an Edinburgh man in an Edinburgh general hospital developed a smallpox rash; this was followed four days later by a smallpox rash in a boy who had been, at the presumed date of his infection, in a bed adjoining that of the first patient. A complicated epidemic picture developed, including the infection of three students, who had had no contact with the hospital patients, and the infection of 16 patients in an associated convalescent home. Many of the convalescent home patients had returned to their own homes before the outbreak declared itself in the convalescent home. There was, therefore, a considerable scattering of infection throughout the south of Scotland.

The only services common to the hospital and the convalescent home were the laundry and the use of an interhospital ambulance which served associated institutions as well as the two which were infected. Investigation of the laundry and ambulance was negative.

The next stage of the Edinburgh outbreak was, as in Glasgow, the development of a group of eight untraceable cases spread over some thirty days in the general population. As in Glasgow, some of these patients were among those whom one would consider unlikely to acquire any prevalent infection.

The geographical distribution of the homes of the untraceable Edinburgh cases was roughly on a line running from the south-west to the north-east of the city. There was no feature of special interest in the social incidence. One Edinburgh patient travelled to Inveramsay in Aberdeenshire during his incubation period. He sickened there and was admitted to hospital in Inverurie. The diagnosis was at first in doubt but was soon confirmed. One known contact of this patient in Inverurie developed smallpox. Another man, who was in Inverurie at the same time, was sent to Onich in the west of Inverness-shire and developed smallpox, from which he died. The secondary case in Inverurie and the Onich case have not been included in any tables in this summary. No proof has been obtained that the Edinburgh outbreak derived from the previous outbreaks.

To sum up the narrative, the Glasgow outbreak consisted of 11 ship cases, 21 untraceable cases, and four contacts; the Fife outbreak was of three untraceable cases, and 26 contacts derived from one of the untraceable cases; and the Edinburgh outbreak was of 13 untraceable cases, 16 cases in a convalescent home, and 7 contacts. The Glasgow and Edinburgh outbreaks were similar in pattern. The dissimilarity of the Fife outbreak may be ascribed in part to the lack of specific control of all known contacts, up to the time when the Medical Officer of Health found that there was smallpox in the county. The ways in which infection spread from one area to another and the ways in which it spread in the two cities remain unknown, though the waves followed at roughly fortnightly intervals, which is consistent with a theory that each wave derived from its predecessor.

*Type of disease.*—The disease was of the major type with a fatality rate of 24%. The type was consistent throughout, except for a relatively small proportion of patients with sparse rashes in Fife and a relatively large proportion in Edinburgh. In Fife five patients had a purpuric eruption, in Edinburgh two. All seven died. In the other patients who died the rashes were hæmorrhagic, confluent, or both.

*Age and sex distributions.*—The age and sex distributions, with which are combined some data on the severity, are given in Table II. This table and all succeeding tables, except when special notes are entered to the contrary, have been drawn up on a subdivision of the clinical type into four broad categories: (a) fatal, (b) confluent (or semi-confluent), with recovery, (c) discrete, with recovery, and (4) sparse, with recovery. Table II has been so arranged that the excess of male cases in the two closed populations (preponderantly males) of the ship and convalescent home can be excluded, as they have been in the figures in brackets.

The proportions of deaths in the two sexes do not differ significantly ( $\chi^2 = 1.79$ ,  $P$  about 0.18). Deduction of the males in the "closed" populations increases the probability that the slight observed differences are sampling errors ( $\chi^2 = 1.08$ ,  $P$  about 0.3).

When classified in four 20-year age-groups (foot of Table II) there is a trend towards worse prognosis as one proceeds to older ages. Data to confirm the high mortality rate in infants, in 1918 to 1939, are absent.<sup>1</sup> It is interesting to see that the group "confluent rash with recovery" vanishes from age-groups of 40 and over as if this type of disease at such ages were transferred wholly into the "fatal" group.

In the age-groups 40 to 59 and 60 to 79, the distribution by severity is remarkably uniform. The data have been regrouped in Table III by combining discrete and sparse rashes and the age-groups 40 to 59 and 60 to 79. The expected independence frequencies are included in Table III, and the observed differences are significant.

*Infectivity.*—In assessing the infectivity of smallpox, one is immediately faced with the fact that known contacts were always offered and rarely refused vaccination. It is also doubtful whether any assumption can be made of the precise stage at which a patient becomes or ceases to be infective. Even in the early stages of the Fife epidemic, most contacts had been recently vaccinated. For sixty days, dating from the probable date of infection of the first Fife patient, no specific measure of control was applied to the general population, and the successive numbers of cases in each wave were 1, 1, 8. The next wave of 17 cases followed the starting of the vaccination campaign, but the patients had been infected before the campaign started. The experience of the convalescent home and ship, in both of which infection was present for a limited time without specific control, has already been mentioned. General vaccination campaigns were started in Glasgow on June 30, in Fife on October 9, and in Edinburgh on November 8.

Apart from consideration of the effect of vaccination, the experience described earlier in this section did not lead one to the conclusion that the infectivity was high except to certain individuals. One must abandon any attempt to assess the infectivity in general or, in particular, in comparable groups of vaccinated and unvaccinated persons. One would also refer to the fact that the majority of the cases did not acquire their infection from

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infantile vaccination so associated ( $\chi^2 = 0.53$ ,  $P$  about 0.47). A comparison of the severities in the 55 persons who recovered, out of this group of 76, is somewhat vitiated by the small numbers in several entries. It is given as Table V, the outstanding features of which are the distribution by severity in the totally unvaccinated and the absence of confluent cases in those vaccinated both in infancy and in 1942.

The group of totally unvaccinated patients is compared with those vaccinated (*a*) in 1942 only, in Table VI, and (*b*) in infancy only, in Table VII. In both tables the more important differences are the high proportion of confluent rashes and the low proportion of milder types in the unvaccinated, and in Table VII the high proportion of milder types in those vaccinated in infancy. The superiority of infantile vaccination, giving even greater attenuation of smallpox than that afforded by recent vaccination, is presumably to be explained by regarding the 1942 vaccination as too recent; otherwise the patients would probably not have developed smallpox.

Patients whose protection depended on vaccination in past years can be subdivided at the median of their distribution by intervals since last vaccination (subdivision at the thirty-five years' interval suffices). The slight difference between two and five deaths in the respective groups, each of 16 patients, may be attributed to sampling errors ( $\chi^2 = 1.65$ ,  $P$  about 0.2).

Comparable splitting of the group of patients who developed smallpox some days after their first vaccination gives Table VIII, which shows considerable significance in the observed differences in deaths and severity, in favour of those who have been vaccinated earlier in their incubation period. The numbers, however, are very small.

Those who were totally unvaccinated did not tend to die because of their old age. Dividing this group at the median and comparing with patients in the same age-groups vaccinated prior to 1942 (and not in 1942) one finds the distribution given in Table IX. When grouped into deaths and recoveries, the observed superiority of the vaccinated group at ages 20 and over is significant. There was no significant difference in those aged less than 20.

The numbers are too small for any exhaustive examination. It may be useful, however, to summarize the conclusions just drawn. Some vaccinated persons did develop smallpox but the disease was less fatal than in the unvaccinated. Neither recent nor infantile vaccination was alone responsible for the saving of lives in the patients under discussion, though both showed association with attenuation of the disease in a group of recoveries. The numbers were insufficient to support any theory of the fading of immunity with the passage of years. In patients depending on remote vaccination for protection, no significant differences were observed in the fatalities of groups below and above the median interval of twenty years since their last vaccination. In persons solely dependent for protection on vaccination performed after presumed infection, earlier vaccinations (nine or more days before the smallpox rash) were associated with significant improvement in fatality and reduction in severity.

Vaccination was offered to all contacts. A large group of vaccinated persons, most of whom had probably or possibly been infected, was built up. Accurate figures of this population were not available at the time of making this summary, but the number of cases of smallpox in recently vaccinated contacts was small. There was an unexpectedly high incidence of systemic disturbances and post-vaccinal rashes, which have been fully described for Glasgow by Napier and Insh (1942), Bloch (1942), and Tyrell (1942). The last writer had the interesting experience of comparing the post-vaccinal reactions in simultaneously vaccinated groups of contacts and non-contacts. Between these groups no significant differences were found, and some doubt is cast on the existence of smallpox without a rash.

One has no intention of discussing purely clinical matters, but the acceptance of a recently vaccinated contact as a case of mild smallpox was sometimes found to be a severe tax on judgment. In persons neither recently vaccinated nor in contact with vaccinia, great help could be obtained by using the modified Gordon test, which was generously performed by Professor W. J. Tulloch.

In the general population about 500,000 persons were vaccinated in Glasgow, 76,000 in Fife, 264,000 in Edinburgh, 40,000 in West Lothian, 45,000 in Midlothian—to give only the largest figures. The proportions of the populations who accepted vaccination were large without precedent. It is probable that the eagerness in acceptance varied as the proximity of smallpox so that even a general offer of vaccination accompanied by, say, 50% acceptance all over implied a much higher acceptance rate in those who were nearest to infection at home or at work. The picture may be compared to a relief map with a case of smallpox at each summit and descending slopes of vaccination acceptance around

any known source, and therefore it cannot be determined how many infective persons (or things) acted as sources of infection.

The last consideration leads to the possibility of "missed" cases or even carriers as sources of infection. Reviewing the range of clinical manifestations of smallpox, especially the rashes from confluent to sparse, one cannot exclude possible extension below the level of clinical recognizability: and this without postulating a change of virulence, either such as that observed in a group of Fife patients or in the opposite sense. To known modifying factors in the host, such as age and vaccinal condition, and to unknown factors may be attributed variations in the clinical picture.

But, to refer to another aspect of this difficult question, it was observed that patients with even scanty rashes had sufficient initial symptoms to make them cease work. Whether any persons, not recently vaccinated, developed the prodromal symptoms but not the eruption, and whether they became infective to others, cannot be determined yet. Special attention has been given to this subject and one expects some interesting results. The existence of carriers remains speculative.

*Incubation period.*—In the few Scottish cases in which it was possible to establish the precise intervals "exposure to sickening" and "exposure to rash", and useful upper and lower limits, the results were consistent with the prevailing opinion.

*Prodromal period.*—Some of the patients appeared to have an unduly long prodromal period and it has been thought worth while to attempt to subdivide the cases according to the periods and the severity of the disease (Table IV). The findings as a whole have been compared with a distribution given for the 1927 minor smallpox in Dundee (Burgess, 1928) and with that of a group of 17 patients in Glasgow and Edinburgh who were admitted to hospital as observation cases of smallpox but eventually found to be suffering from other diseases. These 17 cases have been selected from a large group of admissions for observation, in most of which the prodromal period was doubtful. A trend is seen in the prodromal period, from 2.0 days in fatal cases to 2.95 days in cases with sparse rashes. All groups of major smallpox differ markedly from the mean given by the Dundee figure for minor smallpox. (The actual distribution of the Dundee figures is peculiar.)

Comparison of the 1942 major smallpox cases with the cases not smallpox shows that, so far as this criterion was concerned, there was every reason to regard the observation cases as cases of smallpox and that entirely other considerations—on which no doubt can be cast—led to the establishment of other diagnosis.

How far one can go, if at all, in determining the prognosis of an individual case from knowledge of the length of the prodromal period will have to depend on the assessment of more data than—one hopes—will be available in Scotland for many years to come.

*Vaccination.*—Vaccination will be described in (a) patients, (b) contacts, and (c) the general population. Most of the patients had been vaccinated at some time in their lives. Many had been vaccinated during the incubation period of their smallpox. The data on Glasgow and Fife and the data available for Edinburgh at the time of writing this summary have been tabulated. The tables are not reproduced. There are many factors. Infantile vaccination may not have been performed; if performed, it may or may not have been successful. Subsequent vaccinations up to any number may have been performed and may or may not have "taken". The interval since last vaccination prior to 1942 varies widely. Vaccination in 1942 may or may not have been successful, the last possibility occurring in six persons who shortly developed smallpox, which introduces a fine point in trying to determine why the vaccination was unsuccessful. In patients vaccinated only a day or two before the appearance of a profuse rash the decision whether the vaccination had or had not taken was sometimes impossible.

Many of the older males had been vaccinated in the last war, which has been assumed, in the absence of precise knowledge, to be in 1916. The group of persons "last vaccinated twenty-five to thirty years ago" is, therefore, comparatively large. The tables were drawn up on the assumption that recent successful vaccination would be more highly protective than any vaccination performed years ago or in infancy, i.e. that immunity fades with the passage of time. The order of priority in classification has therefore been: (a) vaccination in 1942, (b) other vaccinations since infancy, and (c) infantile vaccination.

Several comparisons can be made on even these limited data. Patients never vaccinated had a worse prognosis *qua* recovery than those who had been vaccinated at any time in their lives ( $\chi^2=3.96$ , P about 0.046). It is possible to select 76 patients whose vaccinal state is represented by vaccination or lack of vaccination (a) in 1942 and (b) in infancy, without the complication of intermediate vaccination. In these groups successful vaccination in 1942 is not significantly associated with recovery ( $\chi^2=0.83$ , P about 0.36), nor is

TABLE II.—SCOTLAND, 1942: DATA ON SEX, AGE AND SEVERITY OF 99 CASES OF SMALLPOX.

F = Fatal. C = Confluent (recovery). D = Discrete (recovery). S = Sparse (recovery).

F = Fatal; C = Confluent (recovery); D = Discrete (recovery); S = Sparse (recovery).																						
		Age-groups																	Fatal	Confluent	Discrete	Sparse
Categories		0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	55-	60-	65-	70-	75-9	All				
Males						FCD																
Glasgow (Ship) ...	...	D	—	—	DD	DDD	F	C	—	—	—	—	—	—	—	D	F	D	11			
Rest of Glasgow ...	...	—	—	—	DS	D	—	—	CS	FD	—	—	—	—	—	—	—	11	12			
Fife ...	...	—	CS	FD	S	FD	—	S	—	D	—	—	—	—	—	—	—	9	1			
Edinburgh	...	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12			
(Con. Home) ...	...	—	—	CC	CCC	—	F	S	FSS	F	D	—	S	S	SS	—	D	16	3			
Rest of Edinburgh	...	—	—	F	—	—	CDS	—	D	—	—	—	FS	—	—	—	—	10	1			
Totals		1 (0)	2 (2)	7 (5)	7 (2)	10 (3)	5 (3)	3 (2)	6 (3)	4 (3)	1 (1)	—	3 (2)	1 (0)	4 (2)	1 (1)	2 (1)	57 (30)	11 (6)			
Females																						
Glasgow ...	...	—	—	CC	DS	S	FF	CS	C	F	—	D	—	S	—	F	—	14	4			
Fife ...	...	F	CDS	C	D	FF	FC	FC	—	—	—	—	—	—	—	—	—	18	6			
Edinburgh	...	D	—	—	SD	D	—	—	—	—	SD	F	FFD	F	—	—	—	10	3			
Totals		2	3	5	4	7	4	5	2	—	3	1	4	1	1	—	—	42	13			
Both sexes		3 (2)	5 (5)	12 (10)	11 (6)	17 (10)	9 (7)	8 (7)	8 (5)	4 (3)	4 (4)	1 (1)	7 (6)	2 (1)	5 (3)	1 (1)	2 (1)	99 (72)	24 (19)			
Fatal ...	...	—	3	(3)	—	—	12	(8)	—	—	6	(5)	—	—	3	(3)	—	—	(19)			
Confluent ...	...	—	10	(5)	—	—	9	(7)	—	—	0	(0)	—	—	0	(0)	—	—	(12)			
Discrete ...	...	—	11	(8)	—	—	13	(9)	—	—	6	(6)	—	—	4	(3)	—	—	(26)			
Sparse ...	...	—	7	(7)	—	—	8	(5)	—	—	4	(3)	—	—	3	(0)	—	—	(15)			
Totals		31	(23)	—	—	—	42	(29)	—	—	16	(14)	—	—	10	(6)	—	—	(72)			

Figures in brackets are exclusive of ship cases (Glasgow) and convalescent home cases (Edinburgh). Case at Cowdenbeath and case at Thornton omitted.

TABLE III.—SCOTLAND, 1942: SUMMARIZED DATA ON AGE AND SEVERITY OF SMALLPOX.

Severity	0-19		20-39		40-79		All ages
	Observed	Expected	Observed	Expected	Observed	Expected	
Fatal ...	3	7.51	12	10.18	0	6.30	24
Confluent ...	10	5.95	9	8.06	0	4.99	19
Discrete or sparse	18	17.54	21	23.75	17	14.71	56
Total	31	—	42	—	26	—	99

$$\chi^2 = 12.84, P \text{ about } 0.012.$$

TABLE IV.—SCOTLAND, 1942: DATA OF INTERVAL BETWEEN SICKENING AND (SMALLPOX) RASH.

Type	Area		Prodromal period (days)						Definite intervals			Not	Gross	
			0	1	2	3	4	5	6	No.	Mean	S.D.	definite	total
Fatal	...	{ Glasgow ...	...	1	—	3	3	—	—	7	—	—	1	8
		{ Fife ...	...	—	—	6	1	—	—	7	—	—	—	8
		{ Edinburgh ...	...	—	1	1	4	2	—	8	—	—	—	8
			...	1	1	4	2	—	—	8	—	—	—	8
		Total	2	2	13	6	—	—	—	23	2.0	0.83	1	24
Confluent (recovery)	...	{ Glasgow ...	...	—	2	—	5	—	—	7	—	—	—	7
		{ Fife ...	...	—	—	1	2	1	—	6	—	—	—	6
		{ Edinburgh ...	...	—	1	2	1	1	—	6	—	—	—	6
			...	1	1	2	1	1	—	6	—	—	—	6
		Total	1	4	4	8	2	—	—	19	2.32	1.07	—	19
Discrete (recovery)	...	{ Glasgow ...	...	—	—	3	5	2	—	10	—	—	5	15
		{ Fife ...	...	—	—	2	1	3	3	9	—	—	—	9
		{ Edinburgh ...	...	—	—	—	4	4	2	10	—	—	—	10
			...	—	—	—	4	4	2	10	—	—	—	10
		Total	—	2	8	12	7	—	—	29	2.83	0.87	5	34
Sparse (recovery)	...	{ Glasgow ...	...	—	1	3	—	1	—	5	—	—	1	6
		{ Fife ...	...	—	—	1	2	1	—	4	—	—	—	4
		{ Edinburgh ...	...	—	1	1	4	2	1	11	—	—	1	12
			...	—	1	1	4	2	1	11	—	—	1	12
		Total	—	3	6	5	3	1	2	20	2.95	1.47	2	22
All	...	{ Glasgow ...	...	1	3	9	13	3	—	29	2.48	0.95	7	36
		{ Fife ...	...	—	5	11	7	4	—	27	2.37	0.95	—	27
		{ Edinburgh ...	...	—	2	3	11	11	5	35	2.71	1.36	1	36
			...	2	3	11	11	5	1	2	35	2.71	1.36	1
		Total	3	11	31	31	12	1	2	91	2.54	1.13	8	99
"Observation" (not smallpox)		{ Glasgow and Edinburgh	1	2	5	5	4	—	—	17	2.53	1.14	+ +	
V. minor		Dundee (1927)	See below						137	3.47	2.25	15	152	

Case at Cowdenbeath and case at Thornton excluded.

Variola minor	Dundee (1927) Cases	Prodromal period (days)										Doubtful
		0	1	2	3	4	5	6	7	8	9	
		23	4	8	34	22	28	8	6	1	2	15

the peaks. If the numbers of cases in the smallpox waves preceding general vaccination are compared with the numbers in the waves following vaccination, the comparison shows an association in time between the campaigns and the progressive reduction in the waves. Many other factors must have been involved, but the records are consistent with a theory that the spread of smallpox in each area was controlled by vaccination.

The question arose as to when a vaccination campaign should be instituted. During a discussion of this question Sir Alexander Macgregor expressed the opinion that the time to institute a campaign was when the first untraceable case appeared in the general population. When one considers how unpredictable the spread of smallpox proved to be in Scotland last year, one must concur in this opinion.

**Complications of vaccination.**—The most serious complication of the vaccination campaigns was the occurrence of cases of post-vaccinal encephalitis, of which there were seven in Glasgow with two deaths (Anderson and McKenzie, 1942), eight or nine in Fife with four deaths, eleven in Edinburgh with two deaths, seven in the Lothian Counties with four deaths, and one fatal case in Roxburgh County. This experience may be contrasted with that of 1920-21, when 225,000 vaccinations were performed in Glasgow alone, and many others outside Glasgow, without any increase in deaths from vaccination. Further descriptions of the cases in 1942 are in preparation by the medical officers responsible for their investigation and treatment. It may be said, in general, that the epidemiological picture was consistent with that which has already been reported for this illness.

**Administration.**—Sound administrative procedure must depend on accurate knowledge of epidemiology; once the latter is defined the former becomes clear. That does not exclude a reference to the many administrative measures which were adopted or considered, such as the consideration of notification of chickenpox (not instituted in actual fact); liaison with the Services and other departments controlling population movements; vaccination arrangements at public centres or by private doctors; supplies of vaccine lymph; consideration of vaccination of seamen in ocean-going and coastal shipping and the vaccinal state of passengers coming from abroad; the provision of hospital and reception house accommodation; the disinfection of infected articles; and many other questions that defy classification. That these problems met with an adequate solution cannot be doubted when one sees the series of outbreaks as a whole, and I pay tribute to the work and foresight of the staffs who dealt with them.

[The data on which this summary of the Scottish experience of smallpox in 1942 is based have been provided by Sir Alexander Macgregor, Dr. Fyfe, and Dr. Clark, the Medical Officers of Health of Glasgow, Fife, and Edinburgh, to whom I express my gratitude for their generosity and willing co-operation. Some of the data have been made available to me in advance of other publication. So far as has been possible, the data provided by the Medical Officers of Health have been accurate and I must accept the responsibility for any incorrect deductions based on them. I have also assumed that those patients who were still in hospital at the time of writing would recover from their attacks.]

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 TABLE I, Scotland 1918-41. Abstract of data on smallpox and vaccination. Refer to Author.  
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CHART 1.—FIFE SMALLPOX CASES, 1942: SHOWING DERIVATION. DEATHS IN BRACKETS. (CASE AT COWDENBEATH AND CASE AT THORNTON EXCLUDED.)

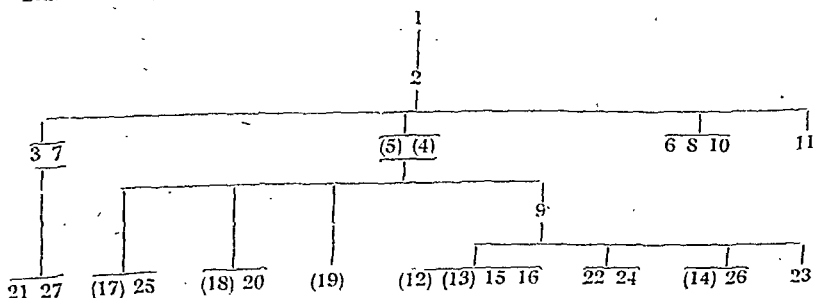


TABLE II.—SCOTLAND, 1942: DATA ON SEX, AGE AND SEVERITY OF 99 CASES OF SMALLPOX.

F = Fatal. C = Confluent (recovery). D = Discrete (recovery). S = Sparse (recovery).

Categories	Age-groups															All	Fatal	Confluent	Discrete	Sparse
	0-	5-	10-	15-	20-	25-	30-	35-	40-	45-	50-	55-	60-	65-	70-	75-9				
Males					FCD															
Glasgow (Ship) ...	D	—	—	DD	DDD	F	C	—	—	—	—	—	—	—	—	—	11	12	7	1
Rest of Glasgow ...	—	—	DS	D	D	—	—	CS	FD	—	—	—	—	—	—	—	11	1	6	3
Fife ...	—	CS	FD	S	FD	—	S	—	D	—	—	—	—	—	D	F	9	2	1	3
Edinburgh	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
(Con. Home) ...	—	—	CC	CCC	—	F	S	S	FSS	D	—	—	S	S	SS	D	16	3	5	7
Rest of Edinburgh	—	—	F	—	—	CDS	S	S	—	D	—	—	FS	—	—	—	10	2	1	4
Totals	1 (0)	2 (2)	7 (5)	7 (2)	10 (3)	5 (3)	3 (2)	6 (3)	4 (3)	1 (1)	—	—	3 (2)	1 (0)	4 (2)	1 (1)	2 (30)	57 (6)	11 (3)	21 (13)
Females																				
Glasgow ...	—	—	CC	DS	S	FF	CS	C	F	—	D	—	S	—	F	—	14	4	4	2
Fife ...	F	CDS	C	D	CD	FC	FC	—	D	—	—	F	—	—	—	—	18	6	5	6
Edinburgh	D	—	—	SD	D	—	—	—	—	SD	—	FFD	F	—	—	—	10	3	—	2
Totals	2	3	5	4	7	4	5	2	—	3	1	4	1	1	—	—	42	13	9	13
Both sexes	3 (2)	5 (5)	12 (10)	11 (6)	17 (10)	9 (7)	8 (7)	8 (5)	4 (3)	4 (4)	1 (1)	7 (6)	2 (1)	5 (3)	1 (1)	2 (1)	99 (72)	24 (19)	19 (26)	34 (15)
Fatal ...	—	3	(3)	—	—	12	(8)	—	—	6	(5)	—	—	3	(3)	—	(19)	—	—	—
Confluent ...	—	10	(5)	—	—	9	(7)	—	—	0	(0)	—	—	0	(0)	—	—	—	—	—
Discrete ...	—	11	(8)	—	—	13	(9)	—	—	6	(6)	—	—	4	(3)	—	—	—	—	—
Sparse ...	—	7	(7)	—	—	8	(5)	—	—	4	(3)	—	—	3	(0)	—	—	—	—	—
Totals	—	31	(23)	—	—	42	(29)	—	—	16	(14)	—	—	10	(6)	—	(72)	—	—	—

Figures in brackets are exclusive of ship cases (Glasgow) and convalescent home cases (Edinburgh).  
Case at Cowdenbeath and case at Thornton omitted.

TABLE III.—SCOTLAND, 1942: SUMMARIZED DATA ON AGE AND SEVERITY OF SMALLPOX.

Severity	0-19		20-39		40-79		All ages
	Observed	Expected	Observed	Expected	Observed	Expected	
Fatal ...	3	7.51	12	19.15	9	6.30	24
Confluent ...	10	5.95	9	8.06	17	4.99	19
Discrete or sparse	18	17.54	21	23.75	0	14.71	56
Total	31	—	42	—	26	—	99

$$\chi^2 = 12.84, P \text{ about } 0.012.$$

TABLE IV.—SCOTLAND, 1942: DATA OF INTERVAL BETWEEN SICKENING AND (SMALLPOX) RASH.

Type	Area	Prodromal period (days)						Definite intervals			Not definite	Gross total
		0	1	2	3	4	5	No.	Mean	S.D.		
Fatal	Glasgow ...	1	—	—	3	—	—	7	—	—	1	8
	Fife ...	—	1	6	1	—	—	8	—	—	—	8
	Edinburgh ...	1	1	4	2	—	—	8	—	—	—	8
	Total	2	2	13	6	—	—	23	2.0	0.83	1	24
Confluent (recovery)	Glasgow ...	—	2	—	5	—	—	7	—	—	—	7
	Fife ...	—	1	2	2	1	—	6	—	—	—	6
	Edinburgh ...	1	1	2	1	1	—	6	—	—	—	6
	Total	1	4	4	8	2	—	19	2.32	1.07	—	19
Discrete (recovery)	Glasgow ...	—	—	3	5	2	—	10	—	—	5	15
	Fife ...	—	2	1	3	3	—	9	—	—	—	9
	Edinburgh ...	—	—	4	4	2	—	10	—	—	—	10
	Total	—	2	8	12	7	—	29	2.83	0.87	5	34
Sparse (recovery)	Glasgow ...	—	1	3	—	1	—	5	—	—	1	6
	Fife ...	—	1	2	1	—	—	4	—	—	—	4
	Edinburgh ...	—	1	1	4	2	1	11	—	—	1	12
	Total	—	3	6	5	3	1	20	2.95	1.47	2	22
All	Glasgow ...	1	3	9	13	3	—	29	2.48	0.95	7	36
	Fife ...	—	5	11	7	4	—	27	2.37	0.95	—	27
	Edinburgh ...	2	3	11	11	5	1	35	2.71	1.36	1	36
	Total	3	11	31	31	12	1	91	2.54	1.13	8	99
"Observation" (not smallpox)		1	2	5	5	4	—	17	2.53	1.14	—	—
V. minor ... Dundee (1927)		See below						137	3.47	2.25	15	152

Case at Cowdenbeath and case at Thornton excluded.

Variola minor	Dundee (1927) Cases	Prodromal period (days)										Doubtful
		0	1	2	3	4	5	6	7	8	9	
		23	4	8	34	22	28	8	6	1	2	15

TABLE V.—SCOTLAND, 1942: SEVERITY OF RASH IN 55 SMALLPOX PATIENTS WHO RECOVERED, GROUPED ACCORDING TO VACCINAL STATE

1942	Vaccinations	Confluent		Discrete		Sparse		Totals
		Observed	Expected	Observed	Expected	Observed	Expected	
—	—	4	3.09	9	8.56	7	6.55	23
—	—	0	2.54	6	4.18	4	3.27	10
—	—	9	2.29	0	3.76	0	2.95	9
—	—	1	4.07	8	6.69	7	5.24	16
Totals		14		23		18		55

$$\chi^2 = 53.3, P < 0.0001.$$

TABLE VI.—SCOTLAND, 1942: COMPARISON OF SEVERITY OF SMALLPOX IN TOTALLY UNVACCINATED PATIENTS AND PATIENTS VACCINATED IN INFANCY ONLY.

Vaccinations	Fatal		Confluent		Discrete or sparse		Totals
	Observed	Expected	Observed	Expected	Observed	Expected	
None ...	7	4.95	9	4.95	0	6.10	16
1942 only	6	8.05	4	8.05	16	9.90	26
Totals	13		13		16		42

$$\chi^2 = 16.6, P < 0.001.$$

TABLE VII.—SCOTLAND, 1942: COMPARISON OF SEVERITY OF SMALLPOX IN TOTALLY UNVACCINATED PATIENTS AND PATIENTS VACCINATED IN INFANCY ONLY.

Vaccinations	Fatal		Confluent		Discrete or sparse		Totals
	Observed	Expected	Observed	Expected	Observed	Expected	
None ...	7	5.19	9	4.32	0	6.49	16
Infancy only	5	6.81	1	5.68	15	8.51	21
Totals	12		10		15		37

$$\chi^2 = 21.5, P < 0.0001.$$

TABLE VIII.—SCOTLAND, 1942: COMPARISON OF SEVERITY OF SMALLPOX IN PATIENTS WHOSE ONLY VACCINATION WAS 3 TO 8 AND 9 TO 14 DAYS BEFORE THE SMALLPOX RASH.

Interval between vaccination and smallpox rash	Fatal		Confluent		Discrete or sparse		Totals
	Observed	Expected	Observed	Expected	Observed	Expected	
3 to 8 days ...	5	2.77	4	1.84	3	7.38	12
9 to 14 days ...	1	3.23	0	2.15	13	8.62	14
Totals	6		4		16		26

$$\chi^2 = 12.8, P \text{ about } 0.0017.$$

TABLE IX.—SCOTLAND, 1942: COMPARISON OF FATALITY OF SMALLPOX IN PATIENTS AGED 20 OR OVER, GROUPED BY VACCINATION PRIOR TO 1942. (PATIENTS VACCINATED IN 1942 ARE EXCLUDED.)

Vaccinations	Fatal		Recovery		Totals
	Observed	Expected	Observed	Expected	
None...	5	2.59	3	5.40	8
Before 1942 only	7	9.41	22	19.60	29
Totals	12		25		37

$$\chi^2 = 4.81, P \text{ about } 0.028.$$

*Discussion.*—DR. J. GLEN: There were 35 cases of smallpox admitted to Robroyston Hospital at Glasgow. Of these 64% were severe. Routine treatment: with sulphadiazine and ascorbic acid was carried out. Eleven of the 35 were cases of confluent smallpox. Eight of these were unvaccinated. The vaccinal history of the other three cases was as follows: One patient was vaccinated seventy-two years previously, one thirty-seven and one thirteen years previously. Three deaths occurred in this group, two in the unvaccinated patients and one in the patient who had been vaccinated seventy-two years before. This represents a mortality of 27%. When one considers the day of illness on which treatment was started, one finds that out of seven patients (five unvaccinated, two vaccinated) where treatment was started before the third day of rash, one death only occurred and that in a patient of 72 who developed pneumonia on the fourteenth day of illness.

*Effects of the drug.*—The other points noted that were common to all the cases treated by the drug were as follows: (1) No toxic manifestations of the drug were observed. (2) No septic complications such as boils, cellulitis, urinary sepsis occurred in any case. There were no severe eye complications. (3) Scarring was relatively slight in even severe cases. (4) Rapid evolution and drying of the lesions occurred. (5) A point remarked upon by a number of medical men with wide experience of smallpox was the lack of odour in the wards.

*Case treated during the invasion period.*—The history of the only case treated in the invasion period is as follows: On June 13, 1942, a man aged 20 and a known contact of smallpox was admitted on the first day of illness to hospital, acutely ill. His temperature was 103° F., pulse 132; he was complaining of severe headache and backache. He was unvaccinated. The routine dosage of sulphadiazine was started on the 14th. His condition was unchanged and his temperature was now 106° F., pulse 140. On the 15th a generalized macular rash was present on the face, arms, shoulders, chest and legs, and by the evening the lesions were already confluent. On the 16th most

lesions were vesicular and the rash was widely confluent, the headache and backache had now gone and the patient's temperature was 101° F., pulse 100. By the 18th almost all lesions had begun to abort and many were already dry. The patient's general condition was good and his temperature and pulse were normal. Thereafter the patient made a good recovery and there was no scarring of any sort. No pustulation took place.

*Comment.*—Though the number of cases treated is small the figures indicate a considerable decrease in mortality as compared with routine methods such as in the Minneapolis epidemic where the mortality in confluent smallpox was 45% (Sweitzer and Ikeda, 1927). The results more or less tally with the findings of such workers as Patel and Haidu (1940), Chari (1942), and Wilkinson (1942), using other members of the sulphonamide group. The fact that in seven cases of confluent smallpox treated early with sulphadiazine the mortality rate was only 14% suggests that the drug is more potent in preventing secondary infection than in dealing with infection already established. Emphasis has not been laid upon this point by other workers.

In all cases treated after the rash had appeared pustulation occurred, and there was no evidence that the course of the virus disease was altered in these cases. The more rapid evolution, the quicker drying of the lesions and the relative lack of secondary fever are looked upon as being due to the prevention or the control of secondary infection. Whether or not the progress of the disease itself as distinct from the secondary infection is influenced by the use of the sulphonamide group of drugs is a point that has caused considerable discussion, and the majority of workers believe that it does not. Pierna (1939) expresses the opinion that sulphanilamide "attenuates the smallpox virus". This opinion is based on the experience of seven cases and evidence produced is debatable.

McCammon (1939) treated four cases of smallpox before the rash appeared and claimed that three of the cases developed a macular rash only, no pustulation occurring. The lack of vaccinal history in his cases reduces the value of his observations considerably. His observation is nevertheless of considerable interest as it is the only record of cases treated with sulphanilamide during the invasion period that I can find, and it seems reasonable that this is the period at which the drug is most likely to have an influence on the virus since the latter is still circulating in the blood-stream. The Glasgow case treated during the invasion period might be an example of a person possessing natural immunity with regard to the lesion-modifying factor but it is well to remember that this particular factor is exceptional in natural immunity as is pointed out by Reckett and Byles (1908). On the other hand it may be that as McCammon suggests the virus disease is influenced by drugs of the sulphonamide group if given sufficiently early. All that can be said at the moment is that a sufficient number of cases have not been reported to justify an opinion on this point.

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Dr. PETER MCKENZIE: *Vaccinal encephalitis*.—In July 1942 approximately 500,000 were vaccinated in the City of Glasgow. There were seven cases of vaccinal encephalitis, the incidence was therefore 1:70,000. In no case did encephalitis follow primary vaccination in infancy, six of the seven cases occurring in previously unvaccinated children between the ages of 2 and 16. Five were males and two females. The day of onset varied from six to fourteen days after vaccination and the duration of illness from five days to six weeks. Two of the male children, aged 2 and 5 years, died: all the others recovered completely.

In six of the seven cases the signs and symptoms indicated an encephalitis without special localization and with little evidence of involvement of the cord, but the remaining case, a boy of 16, gave a true clinical picture of transverse myelitis. Findings of interest in the cerebrospinal fluid were: (1) cell count varied from 6/c.mm. to 144/c.mm., the cells being mainly monocytic; (2) the colloidal gold reactions showed a tendency towards luetic zoning and one showed a true luetic curve; (3) Wassermann reaction was negative in all cases; (4) protein, globulin and chlorides were within normal limits.

*Treatment.*—Three cases were admitted in deep coma. Two of them received serum treatment; the first, anti-vaccinal horse serum; the second, anti-vaccinal horse serum, whole blood and serum from father, vaccinated fifteen days previously. Both patients treated with serum died; the third case made a complete recovery.

*Eruptions following vaccination.*—(1) Accidental vaccination; (2) eczematoid eruption; (3) erythema multiforme iris; (4) urticaria—papular and circinate; (5) roseola. [Photographs of these eruptions were shown.] The causative factors are not clear



but from appearance, one could consider all but accidental vaccination as allergic or toxicemic.

*Kaposi's varicelliform dermatosis.*—During the epidemic period two children and one adult were admitted to hospital suffering from Kaposi's varicelliform dermatosis: all three had a history of previous eczema and were unvaccinated. Individual pustules in no way resembled varicella but were varioliform in character. Crusts from two of the cases gave positive serological tests for vaccinia and Professor Tulloch of Dundee stated that where smallpox is known to be present in a population, a positive flocculation or complement-fixation test with pock virus antigen—especially with crusts from adults—should be regarded as suspicious of smallpox.

It is known that a further seven cases of Kaposi's varicelliform dermatosis occurred in Glasgow during the smallpox epidemic and considering the rarity of the condition this must be regarded as of some significance. It is advisable, therefore, that all such cases arising during a period of smallpox prevalence should be placed in isolation and await appropriate serological tests.

Dr. R. GAUTIER (Officer-in-Charge of the Health Service of the League of Nations) stressed that the source of the lymph used was important, since continental experience suggested that encephalitogenic properties differed according to the strain. He emphasized the need for control of the lymph used in order to prevent loss of potency through storage. Dried lymph had proved capable of retaining its activity even after a long period of storage under tropical conditions; it had been largely used by the Dutch and French Colonial Medical Services.

Dr. ANDREW DAVIDSON said that although it was difficult to dissociate the outbreaks in Glasgow, Fife and Edinburgh from a common source, no connexion was established between any two.

How could the absence of secondary cases be explained from the tram conductress who was on duty for two days while suffering from the disease? Again, there was the infected person who travelled from Glasgow to Liverpool and back again and who subsequently died from confluent smallpox a few days after his return, and yet left no secondary cases in his trail. How was the infection conveyed to an inmate of a mental hospital who had not been outside the institution for fourteen years, who had had no visitors for more than three weeks, and who died after a severe attack? Only one other case occurred in this mental hospital; this case had no direct connexion with the first. Problems associated with vaccination included the very severe reactions in some districts; a relatively high incidence of post-vaccinal encephalitis; the occurrence of smallpox in persons who had been unsuccessfully vaccinated on one or more occasions; and cases occurring in successfully vaccinated persons at varying periods up to ten days after vaccination.

The administrative problems related to the Scottish outbreaks of smallpox were mainly concerned with port sanitary administration. Some of these were the war-time difficulties of communication between a ship at sea and the port health authority; diversion of ships at the last moment from one port to another; war-time use of small ports deficient in equipment and medical staff; the vaccination state of crews sailing to and from ports likely to be infected; and vaccination of crews of coastal ships. The Ministry of War Transport had commenced a scheme aimed at improving the vaccination state of crews sailing to such ports, while the question of vaccination of passengers coming from ports likely to be infected was under consideration.

In conclusion, Dr. J. D. ROLLESTON (in the Chair) said that, like Colonel Butler and Dr. Brincker, he had served in the smallpox epidemic of 1901-3. He had never seen a case of genuine smallpox among the many patients erroneously certified as such if successful vaccination had been performed within the five years previous to exposure to the disease.

As regards the clinical aspects, he alluded to the appearance of the tongue in hæmorrhagic smallpox which seemed to be covered with a thick coating of white paint.

Owing to the rarity of post-vaccinal encephalitis during the first year of life, which T. F. McNair Scott<sup>1</sup> had collected only 41 cases, it was most important that vaccination should be performed during that period, especially during the first three months of life. The presence of a skin eruption was a contra-indication to vaccination.

## Section of Radiology

President—F. M. ALLCHIN, M.B.

[January 15, 1943]

DISCUSSION ON THE VALUE OF IRRADIATION  
IN ASSOCIATION WITH SURGERY IN THE  
TREATMENT OF CARCINOMA OF THE BREAST

Air Commodore Stanford Cade: Cancer of the breast may be classified according to histological structure or clinical type. The histological varieties are papillary, intraduct, adenocarcinoma, scirrhus and medullary; the clinical types are scirrhus, encephaloid, duct carcinoma, atrophic scirrhus and Paget's disease of the nipple.

It is possible to assess the prognostic significance of each clinical and histological variety. It is possible to study not only the general histological pattern but the degree of cell differentiation, and to grade malignancy accordingly. Prognosis may also be studied from the point of view of the *patient* who bears the tumour, according to age, or the physiological state of the breast and the rate of growth.

Of all the factors affecting prognosis the *extent* of the disease is the most important, both as to the selection of the methods of treatment and the prognosis. The following clinical classification of mammary cancer is based solely on the extent of the disease: Stage I: Tumour of the breast only. Stage II: Tumour of the breast plus skin changes and/or palpable axillary glands. Stage III: As Stage II and/or supraclavicular or contra-lateral axillary glands or fixation to the pectoral fascia. Stage IV: Visceral or skeletal metastasis (regardless of local extent).

Radical surgery of carcinoma of the breast under the best possible conditions has given striking results.

TABLE I.—CARCINOMA OF THE BREAST—RESULT OF RADICAL MASTECTOMY  
(G. GORDON-TAYLOR, 1938)

Stage of Disease	10 years %	Survival 5 years %	3 years %
I ... ..	84.07	85.88	85.4
II ... ..	29.4	39.9	46.8
III ... ..	6.5	9.8	10.1

Gordon-Taylor's figures demonstrate that in the early stages the survival rate is very high and *remains* high for periods up to ten years: that in Stage II there is a falling off both in the total survival rate and in the relative survival rate at three, five and ten-year periods, and finally that in Stage III—90% of the patients die within the first three years.

The assessment of results of radical surgery when considered on a larger scale is certainly less impressive.

TABLE II.—CARCINOMA OF THE BREAST—RESULT OF SURGERY.  
(COLLECTED INVESTIGATION B.M.A.—LUFF, 1932.)

Stage of Disease	Survival of 4 years or more %	Recurrence after operation %
I ... ..	32.5	10.5
II ... ..	24.6	25.8
III ... ..	3.3	70.0

In the collective investigation by the B.M.A. of a total of 929 cases, 51.9% survived under four years and 27.4% survived over four years.

A comparison of even so short a period as a three-year survival rate from three different sources shows how the average falls below the best.

TABLE III.—CARCINOMA OF THE BREAST—POST-OPERATIVE THREE-YEAR SURVIVAL.

Author	Stage I %	Stage II %	Stage III %
Gordon-Taylor ...	85.1	46.8	10.1
B.M.A. ...	32.5	24.6	3.3
Ministry of Health ...	65.80	30.0	8.0

Radiation by radium can achieve results as good as those obtained by radical surgery.

TABLE IV.—CARCINOMA OF THE BREAST—NET SURVIVAL RATES BY INTERSTITIAL RADIUM (GEOFFREY KEYNES, 1937).

			Radium (G.K.)	Surgery (U.C.H.)
	Stage	No.	Net survival	After surgery
At three years	I ...	85	83.5	79.2
	II ...	91	51.2	52.3
	III ...	74	31.4	—
At five years	I ...	75	71.4	69.1
	II ...	66	29.3	30.5
	III ...	60	23.6	—

These results have a historical interest as this was the first attempt to treat *operable* as well as other cases by radiation alone.

My own results in a series of 213 cases treated by radium and surgery combined or by radium alone are as follows:

TABLE V.—CARCINOMA OF THE BREAST. FIVE YEAR SURVIVAL AFTER RADIUM ALONE OR RADIUM AND SURGERY (S. CADE, 1940).

Stage	Total treated	Alive free from disease	Died of Cancer 6th to 13th years	Died of intercurrent disease 6th to 13th years	Total 5 years survival
					No. %
I ...	57	28	4	8	50 87.7
II ...	81	17	4	3	24 29.6
III ...	63	13	2	1	16 25.4
IV ...	12	0	—	—	0 0.0
All stages ...	213	68	10	12	90 42.25

The results of modern radical mastectomy in early cases are the greatest achievement of surgery in the treatment of cancer in any site and yet in spite of this achievement the number of deaths from cancer of the breast is steadily and relentlessly increasing. To correlate the very high percentage of surgical cures (in the early cases) with the high annual figure of the mortality from cancer of the breast—it is only necessary to analyse the material which presents itself for treatment, when at once it becomes apparent that only a small percentage of women with cancer of the breast can be offered the *best outlook* with surgery and that the remainder—the majority of patients—must rely upon radiation either alone or in combination with surgery to improve their chances of survival.

Radiation has raised the five-year survival in Group III from 0 to 10% to the level of 25% as seen from the various tables (*see* Table VI). If all stages are taken together the figures of Westermarck at the Radiumhemmet show that a 20% five-year survival after operation alone is raised to 30% if post-operative radiation is used and to 40% if both pre- and post-operative radiation is given.

TABLE VI.—PERCENTAGE OF FIVE-YEAR SURVIVAL.

	G.T.	U.C.H.	G.K.	S.C.
Stage II ...	39.9	30.5	29.3	29.6
Stage III ...	9.8	—	23.6	25.4

A combination of treatment by radiation and surgery is not a compromise, it is an attempt to place more advanced cases, borderline cases, cases of Stages II and III into a more favourable group.

*Methods of treatment.*—These cases need one or other combination of therapeutic measures.

#### CHOICE OF METHOD OF TREATMENT.—STAGE II.

Skin nodule ...	...	...	...	...	Radiation only.
Fungation or local ulcer ...	...	...	...	...	Conservative surgery and radiation.
Enlarged axillary glands ...	...	...	...	...	Pre-operative radiation, surgery and post-operative radiation.

Radiation has also given us a powerful weapon in the fight against post-operative recurrences and each type of recurrence requires a different method of attack.

#### CHOICE OF METHOD OF TREATMENT OF RECURRENCES.

Site of recurrence	Method of treatment
Discrete skin nodules ...	Low voltage X-ray or surface radium
Massive subcutaneous nodules ...	Interstitial or 2 stage radium
Supraclavicular gland ...	Teleradium or X-rays
Sternum ...	Radium
Skeletal metastasis ...	High voltage X-rays
Visceral metastasis ...	No radiation of value

The most difficult assessment to make is the value of pre- and post-operative radiation in the *early* and *favourable* case. If the figure of 70 to 80% of five-years' survival can be achieved without radiation—then why irradiate? The answer, I believe, is that this high figure is only achieved exceptionally by the few, in a relatively small proportion of women with cancer of the breast and that it is not always possible to be certain that the case is as early as it appears to be.

I am convinced that X-radiation can achieve complete regression of a carcinoma of the breast in some cases; it is moreover a more flexible weapon than radium. I am equally convinced that there is a place for all types of radiological technique both by X-rays and radium and no single piece of apparatus and no one technique is the panacea for all ills.

*Conclusion.*—In cancer of the breast combined surgical and radiological treatment is the treatment of choice. Skilled radiotherapy is no longer an *auxiliary* method but of equal, and in some cases, of *greater* importance than surgery.

**Dr. R. McWhirter:** The five-year survival rate of all cases of carcinoma of the breast referred to a large general hospital is probably not more than 20% when surgery is the only method of treatment available.

Of the cases in which an operation is performed, failure to eradicate the disease may be due to either or both of the following causes: (1) Distant metastases have already been present. (2) Malignant cells have been left behind in the operation area.

If distant metastases are present by the time the operation is undertaken no known method of treatment is of any avail so far as cure is concerned. If, however, the remaining malignant cells are confined to the vicinity of the operation area a potential failure may be converted into a success by irradiation of this area, provided always that the irradiation given is effective in destroying cancer cells.

In order to determine the value of post-operative radiotherapy the following investigation was undertaken in co-operation with the surgical staff of the Royal Infirmary in Edinburgh. All cases of carcinoma of the breast were divided into four groups or stages according to the extent of the disease as determined clinically. The method of staging adopted is that used by Dr. Ralston Paterson of Manchester. Stage I: The growth is confined to the breast. Involvement of the skin directly over and in continuity with tumour does not affect staging, provided that the area involved is small in relation to the size of the breast. Stage II: As Stage I, but there are palpable mobile glands in the axilla. Stage III: The growth is extending beyond the corpus mammae as shown by: (a) The skin is invaded or fixed over an area large in relation to the size of the breast. (b) The tumour is fixed to underlying muscle. Axillary glands may or may not be palpable, but if glands are present they must be mobile. Stage IV: The growth has extended beyond the breast area, as shown by: Fixation or matting of axillary glands indicating extension outside the capsule, complete fixation of tumour to chest wall, secondaries in supraclavicular glands, secondaries in skin wide of tumour, secondaries in opposite breast, or distant secondaries, e.g. bone, liver, lung, &c. Paget's disease of the nipple is accepted as a primary duct carcinoma, and staged I unless palpable glands are present.

All cases in Stage IV were rejected as being unsuitable for the investigation because many of them were beyond any method of treatment and even when treated few survive for any length of time.

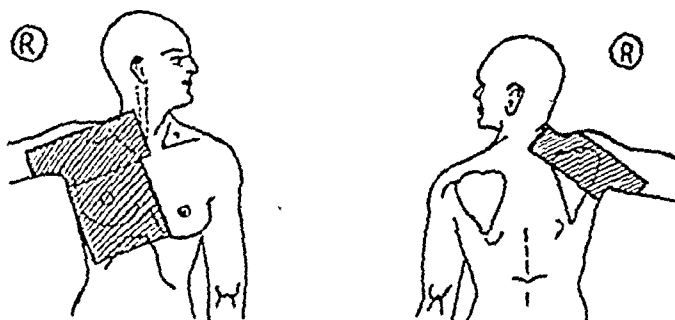
The remaining cases in Stages I, II and III were accepted as suitable if they fell into either of the following two categories. (A) Cases treated by radical operation but not receiving any post-operative radiotherapy as part of the originally planned treatment; and (B) cases treated by operation (whether the operation was radical or not) and by complete post-operative radiotherapy.

For the purposes of this investigation complete post-operative radiotherapy was considered to be the delivery of a minimum tissue dose of not less than 3,500 r in four weeks to an area including the supraclavicular region, the whole length of the axillary chain of glands and the chest wall on the affected side. (In the majority of cases the minimum tissue dose was 4,500 r in four weeks.)

It will be noted that the area treated by radiotherapy (*see figure*) is more extensive than the area treated by surgery even when a radical operation is performed. The area treated by radiotherapy will be referred to subsequently as the "treatable area".

The first step in the investigation was to try to determine how often malignant cells were left behind in the "treatable area" after operation. This point cannot be determined

directly but some indication of the frequency is given by the number of recurrences which become clinically obvious at a later date.



Area treated by X-rays.

Following complete post-operative radiotherapy the recurrences in the "treatable area" are considerably less especially during the first year.

TABLE I.—RECURRENCE RATE IN "THE TREATABLE AREA" EXPRESSED AS A PERCENTAGE OF THE TOTAL CASES TREATED ONE, TWO AND THREE YEARS AGO.

Radical Surgery alone					Surgery + Radiotherapy.				
Stage		1 year	2 year	3 year	Stage		1 year	2 year	3 year
I	New recur. "I.T.A."	22	0	7	I	New recur. "I.T.A."	4	2	1
	Total cases	163	160	150		Total cases	101	127	91
	% of new recur.	13.5	5.6	4.7		% of new recur.	2.1	2.4	1.1
II	New recur. "I.T.A."	18	5	6	II	New recur. "I.T.A."	6	7	2
	Total cases	79	78	75		Total cases	131	83	50
	% of new recur.	22.8	6.4	8.0		% of new recur.	4.6	8.4	4.0
III	New recur. "I.T.A."	20	5	2	III	New recur. "I.T.A."	4	5	0
	Total cases	103	103	97		Total cases	102	68	47
	% of new recur.	28.2	4.9	2.1		% of new recur.	3.9	7.4	0

The figures for the second and third years are of less value for (as will be seen later) the survival rate is lower when radical surgery alone is employed and hence there are fewer cases in which local recurrences can take place. The diminution in the local recurrence rate would be expected to give a higher survival rate and in fact does so, but the assessment of the value of post-operative radiotherapy by this means would not give an accurate indication of its value. Many of the patients treated by radical operation alone in the first place subsequently received radiotherapy when recurrences developed and some of these patients have apparently been "cured". The symptom-free rate is, therefore, a better method of assessment as it indicates the success or failure of the first planned method of treatment (either radical surgery alone or surgery combined with complete post-operative radiotherapy). It was found when large numbers of cases were examined that the three-year symptom-free rate (i.e. symptom-free for three years and not just symptom-free at the end of three years) corresponds very closely to the five-year survival rate. The three-year symptom-free rate, therefore, is not only a better method of assessment than the five-year survival rate but its adoption permits of a saving of time amounting to two years.

TABLE II.—"SYMPTOM-FREE RATE."

Radical Surgery Alone.					Surgery + Radiotherapy.				
Stage		1 year	2 year	3 year	Stage		1 year	2 year	3 year
I	"Symptom-free"	123	105	82	I	"Symptom-free"	169	100	60
	Total cases	163	160	150		Total cases	191	127	91
	% "symptom-free"	75%	66%	55%		% "symptom-free"	88%	78%	67%
II	"Symptom-free"	50	35	22	II	"Symptom-free"	107	53	29
	Total cases	79	78	75		Total cases	131	83	50
	% "symptom-free"	63%	45%	29%		% "symptom-free"	82%	64%	58%
III	"Symptom-free"	50	31	21	III	"Symptom-free"	86	36	21
	Total cases	103	103	97		Total cases	102	68	47
	% "symptom-free"	49%	30%	22%		% "symptom-free"	84%	53%	45%

Symptom-free rates and not survival rates are given and the method of staging is based on clinical findings alone and is not the Steintal method. In the Steintal method

of staging a case is only placed in Stage I provided that the axillary glands show no evidence of secondary involvement on *histological* examination. Of 215 cases in "Clinical" Stage I histological examination of the glands showed the presence of cancer cells in 49% of cases. On the other hand of 175 cases in "Clinical" Stage II only 17% were found not to have secondary involvement of the glands when these were examined histologically.

For interest, the symptom-free rates of the cases in which histological examination of the glands was carried out are provided below:

TABLE III.—"SYMPTOM-FREE" RATE. STAGES I AND II.

Glands Histologically Negative.					Glands Histologically Positive.				
		1 year	2 year	3 year		1 year	2 year	3 year	
Radical surgery	"Symptom-free"...	55	46	38	Radical surgery	"Symptom-free"...	64	48	31
	Total cases ...	65	64	62		Total cases ...	107	105	99
	% "symptom-free"...	85%	72%	61%		% "symptom-free"...	60%	46%	31%
Surgery + radio-therapy	"Symptom-free"...	70	53	35	Surgery + radio-therapy	"Symptom-free"...	108	57	37
	Total cases ...	72	58	39		Total cases ...	136	96	66
	% "symptom-free"...	97%	91%	90%		% "symptom-free"...	79%	59%	56%

Again it will be noted that post-operative radiotherapy leads to considerable improvement in the results.

The three-year symptom-free rate is higher because the local recurrence rate is reduced and it is interesting to note that the improvement in the symptom-free rate is approximately what might be expected from the reduction obtained in the local recurrence rate.

In Stage I cases, the total recurrence rate for three years with surgery alone is 23.8%. Following post-operative radiotherapy the total recurrence rate is 5.6%. The difference of 18% is approximately the same as the difference in the symptom-free rates—i.e. 22%.

In Stage II the corresponding figures are 20% and 29%, and in Stage III 24% and 23%.

The investigation, therefore, shows that: (1) In the performance of the radical operation for cancer of the breast, malignant cells are often left behind in the area which can be treated by radiotherapy. (2) Effective post-operative radiotherapy reduces the local recurrence rate. (3) By reducing the local recurrence rate many potential failures are converted into successes and the three-year symptom-free rate is materially raised.

The investigation has now been carried a stage further and an attempt is being made to determine the results from a combination of radiotherapy and surgical removal of the breast alone. In this series the pectoral muscle is not removed and the axilla, even when glands are obviously present, is not dissected. It will be some time yet before the results are available and I would most strongly suggest that this method of treatment of carcinoma of the breast should not be adopted in other centres until its value has been determined.

Mr. J. Jackson Richmond [*Abridged*]: Considerable evidence now exists revealing the improved results obtainable in the treatment of breast cancer by the combination of irradiation with radical mastectomy. In the case of post-operative irradiation there is a good deal of statistical support to the claim that the survival rate has increased, but in the case of pre-operative irradiation we are bound to rely on somewhat indirect evidence.

Pfahler and Vastine obtained an increase of 10% in the five-year survival rate of their Stage II cases when employing both pre- and post-operative irradiation in place of post-operative irradiation alone. These results have been confirmed by other workers.

[A table was shown which was adapted from Harrington's review of over 4,700 cases of breast carcinoma having radical mastectomy at the Mayo Clinic. 3,254 of these patients received post-operative therapy; 1,426 patients were not irradiated.]

The question arises concerning the circumstances under which pre- or post-operative X-ray therapy should be employed. Each procedure plays a distinct role and they should not be regarded as alternative measures. The key to the position probably lies in a study of the pathological grading or degree of malignancy of the tumours comprising each operable group.

[Tables were shown comparing survival rates of the four histological grades of malignancy following radical mastectomy with and without post-operative irradiation in both Stage I and Stage II cases.]

We are now in the position to formulate a treatment plan for the respective groups of patients.

First, in Stage I cases, radical mastectomy should be performed without delay. It is here that the operable results are so favourable and it may be expected to render 75% or more of cases free from disease at the end of five years. Nevertheless, the results can be improved further and consequently a course of post-operative irradiation is commenced

two weeks after operation, except in the relatively small number of histologically Grade I cases which can be safely treated by surgery alone.

In Stage II a high proportion of the cases will fall into the more malignant Grades 3 and 4. Consequently, a course of pre-operative therapy is administered for two weeks and then radical mastectomy is performed. This is followed in three weeks with a course of post-operative irradiation. It is in the undifferentiated tumours of Stage II that the combination of pre- and post-operative irradiation has improved the survival rate considerably.

Undoubtedly, radical mastectomy remains the spearhead of attack in the treatment of breast cancer despite a certain trend of opinion in this country and abroad to favour local mastectomy combined with irradiation therapy in early Stage I cases. It is in these very cases that the radical operation has shown consistently good results and attempts at conservatism lead to a fall in the survival rate, mainly because we cannot be certain when we are dealing with a definitely early breast cancer.

On the other hand, it is unwise to perform radical mastectomy in cases which originally definitely fell into the inoperable Stage III class, but became apparently operable subsequent to a course of irradiation. This does not apply to cases which were initially on the borderline of operability. The irradiation may have caused quite dramatic regression of the tumour, but it cannot be assumed that it has changed the original pathological grouping of the case. Unquestionably, radiotherapy is the treatment of choice for these patients.

#### RADICAL AMPUTATION, WITH AND WITHOUT POST-OPERATIVE IRRADIATION (HARRINGTON).

	3 years		5 years		10 years	
	No. of patients	% survivals	No. of patients	% survivals	No. of patients	% survivals
With axillary metastasis	2,240	43.2	2,011	29.4	1,457	16.1
A. With irradiation						
B. Without irradiation	747	38.6	732	24.3	653	14.1
Without axillary metastasis—						
A. With irradiation	1,014	84.4	858	75.4	588	55.1
B. Without irradiation	715	81.1	664	70.2	521	53.7

#### CARCINOMA OF BREAST. STAGE I. (WITHOUT AXILLARY METASTASIS.) MAYO CLINIC.

Pathological grading	3 years		5 years	
	No. of patients	% survivals	No. of patients	% survivals
With irradiation—				
Grade 1	66	98.5	54	100
2	162	92	126	87.3
3	244	85.2	180	73.3
4	133	76.7	97	62.9
Without irradiation—				
Grade 1	83	94	62	88.7
2	124	86.3	109	76.1
3	120	74.2	115	56.5
4	104	60.6	101	53.5

#### CARCINOMA OF BREAST. STAGE II. (WITH AXILLARY METASTASIS.) MAYO CLINIC.

Pathological grading	3 years		5 years	
	No. of patients	% survivals	No. of patients	% survivals
With irradiation—				
Grade 1	8	100	7	100
2	143	63.6	136	47.1
3	615	52.4	567	34.2
4	1,293	36.3	1,121	23.6
Without irradiation—				
Grade 1	3	100	3	100
2	46	76.1	46	58.7
3	209	45.5	207	26.1
4	359	28.5	376	18.4

Air Commodore Geoffrey Keynes said that he was in agreement with the findings in Air Commodore Cade's paper.

## Section of Psychiatry

President—J. BRANDER, M.D.

[February 9, 1943]

### DISCUSSION ON THE QUALITY OF MENTAL TEST PERFORMANCE IN INTELLECTUAL DETERIORATION

Major E. L. Trist and Mrs. Virginia Trist: The neuropathology of post-contusional states is obscure. Their psychological effects vary both in kind and degree. Until he has built up a sound stock of control information by studying states of known neuropathology the psychologist is not likely to advance the understanding of post-contusional states very far. Dr. Aubrey Lewis thought that one clinical group of known neuropathology which would provide relevant control information on the post-contusional state was cases of treated general paralysis of the insane in which the disease was judged to have been arrested. In such a group one could safely assume the existence of an organic lesion. The type of lesion moreover is known to be widespread and diffuse and to involve the frontal areas. It was just such cases of general rather than focal involvement which it was desired to study. The present investigation is concerned therefore with a group of treated G.P.I. and the comparison of their performances on certain tests with neurotics and normals.

The word deterioration as currently used may mean anything from a drop in a matrix score to a change for the worse in the personality as a whole. While in clinical work it is always necessary to consider the patient as a whole, in experimental work it is just as necessary to take problems one by one—so long as the problem by itself is not confused with the patient as a whole. Accordingly in the present investigation one psychological process was selected for study, namely that of abstract thinking.

Our aim was to devise a battery of short abstraction tests which would be easy to administer under conditions of clinical interview and would discriminate between reduction of the ability to abstract dependent on a widespread lesion such as occurs in G.P.I. and low-grade normal intelligence or the psychopathological disturbance of efficient intellectual functioning by neurosis.

I.—TESTS USED.—Five tests were used, a vocabulary test to secure an estimate of previous level, and four abstraction tests to obtain a picture of the pattern and extent of present dysfunction. The tests were:

(1) *Card vocabulary*.—Twenty alternate words from the Shipley Vocabulary Test, each stimulus word and its four choice words printed in large type on separate cards, and each word pronounced for the subject as well as shown. All cards on which errors were made were shown a second time at the end of the session. As a control, the other half of the Shipley Vocabulary Test was given in the usual way.

(2) *Similarities*.—The similarities from Wechsler's Bellevue Scale were used, but the method of administration was modified, prompting technique being introduced: (a) particularly when differences were given the mistake was pointed out, and (b) if failure still occurred, the verbal schema for a similarity was supplied.

(3) *Ambiguous pictures*, adapted with modifications and additions from Dworetzki. Six pictures were used. Subjects were asked to give alternative interpretations for each picture.

(4) *Ambiguous shapes*.—A form sorting test consisting of three solid squares, three hollow squares, three solid circles and three hollow circles. Part 1: sorting into four



groups by identical shape; Part 2: sorting into two groups; Part 3: sorting into two groups another way. Separate assessments of the sorting performance and the verbal account of the basis of this performance. Prompting technique: discursive correction of mistakes in sorting and verbalization over five trials. If failure still occurred, two further demonstration techniques were introduced. These prompting techniques were introduced for each of the three parts separately as required.

(5) *Form Colour Sorting Test*, modified and elaborated from Weigl. The changes consisted in: (a) introducing a separate set of white objects; (b) introducing an elaborate inquiry into the sorting performance by means both of questions and supplementary test procedures based on the method of equivalent stimuli.

The tests were given in the following order: (1), (4), (2), (3), (5).

II.—EXPERIMENTAL GROUPS.—The investigation was designed to isolate the effects on the tests of diffuse cerebral lesion involving the frontal area. The experimental groups were chosen to this end.

	Number of cases
(1) <i>Normals</i> .—Equal samples from five matrix selection grades ... ..	125
(2) <i>Neurotics</i> .—Consecutive intake at Mill Hill E.M.S., matrix selection grades IV and V ... ..	30
(3) <i>Paretics</i> .—Treated G.P.I. working patients at Horton and West Park Mental Hospitals. Non-psychotic, at least two years after treatment with malaria, and judged clinically stable over last year at least ... ..	25

### III.—RESULTS OF TESTS CONSIDERED SEPARATELY.

(1) *Card vocabulary*.—The main interest was in the card method. This was successful so far as there was no significant difference between the G.P.I. and the other groups, although differences were significant when the test was given in the ordinary way. The results are, however, complicated by the fact that many low level normals as well as G.P.I.s increase their scores when the card method is used. Moreover, elaborate standardization data for the test which has now become available through the Army have shown it to be of poor discriminative value among British subjects. Also, correlations between the test and other measures of intelligence are not high. The whole question of estimating previous level by vocabulary technique needs much fuller exploration. Although estimates are made on the basis of the present results, the effort has been rather to make the abstraction tests independent of vocabulary by the introduction of pattern analysis.

(2) *Similarities*.—The low scores, in the neighbourhood of zero, expected, were obtained, with one or two exceptions only, among the parietic group. With regard to the exceptions, there was independent evidence that deterioration was non-existent or relatively mild. But since low scores were also expected, and obtained, from many of the Selection Grade Vs, among the normal and neurotic groups, interest centred on qualitative differentia. There were three:

(a) *Persistent giving of differences*: despite all attempts to stop this by prompting technique. Twenty G.P.I.s gave more than five differences, twelve more than ten, three more than twenty; only two normals gave more than five, none more than ten.

(b) *Verbosity*: Elaboration of talk was a feature of twenty-two G.P.I. records. A quantitative criterion may be obtained by taking a word count over the first five easy test items, where normals usually give one or two word answers. Twenty-two G.P.I.s used more than forty words over these items. Only two normals exceeded forty words. Qualitatively, the type of elaboration may be distinguished from that occurring among some psychotics by the absence of thought disorder. It is an enumerative type of elaboration and is characterized by chain associations. The wealth of information and of vocabulary may be exceedingly great. It led away from, not towards, a similarity. The criterion of paying special attention to the first five test items is used partly to save labour, since the computation involved in counting the hundreds of words sometimes used over the whole test is considerable, and partly because the phenomenon, if it is characteristic of a record, appears at once, at the beginning of the test, among the easy items.

(c) *Failure to increase score under prompting*: In no case was the score of a G.P.I. with an initial similarities score of less than five raised by more than two points. Among other groups, the giving of the verbal schema usually raised the score by considerably more than this, sometimes by as much as eight points.

These three criteria (a, b, c), taken together, form a syndrome of positive signs. The full syndrome, on a background of low scores, is present in seventeen out of the twenty-five G.P.I. records. It is not fully present in any normal or neurotic record. Two S.G. Vs showed two of the signs, differences and verbosity, but in each case their scores improved out of all proportion under prompting. It is to be noted that the diagnosis of these qualitative signs is related, in each case, to statistically significant quantitative frames of

reference: more than five differences, more than forty words on the first five items, not more than two points increase of score under prompting.

(3) *Ambiguous pictures*.—The pictures can be interpreted either according to the whole or to the parts. An attempt was always made, sometimes under considerable pressure, to get interpretations on both bases. Whole answers were analysed under the following headings: normal, incomplete, disorganized. Part answers were classified as: generic detail, complete enumeration, incomplete enumeration, disorganized. For both wholes and parts, incomplete and disorganized responses were summed under the title of inadequate answers. Only six normals gave more than three inadequate answers, none more than four. Only five G.P.I.s gave less than four inadequate answers, seventeen gave five or more. Of special significance were failures to give alternative interpretations to a picture. One normal only had more than two failures, whereas seventeen G.P.I.s had more than two. Analysis of generic detail was found to follow intelligence level closely. It faded out almost entirely among the G.P.I.s.

No attempt was made to construct positive signs from the data of this test, but the fact that a significantly greater number of failures and inadequate answers occur among the G.P.I.s enables it to be utilized in computing the total deviation score as described below.

Some pictures proved more diagnostic than others. Sufficient has been learnt to make possible the construction of a much more effective test along these lines. The test also gives information on what might be termed constructive spontaneity, but a suitable method of recording this was only discovered in the process of testing and therefore cannot be systematically reported. While, therefore, the present test does not add much to the information obtained elsewhere in the battery, it indicates the lines for devising a new test to assess constructive spontaneity of form interpretation.

(4) *Ambiguous shapes*.—As will be shown below, the value of this test in the battery cannot be assessed except in relation to the Form Colour Sorting Test, since the absence of transfer effect, i.e. learning, among G.P.I.s as contrasted with the other groups, is one of the most diagnostic features of the whole battery, and comes out in the Form Colour Sorting Test, which was always given after ambiguous shapes.

The number of errors made by the G.P.I.s as a group on this test is twice as great as those made by low grade normals and low grade neurotics. Although this result is statistically significant, there is considerable overlap. This overlap is accounted for by the fact that any individual of low grade intelligence tends to do poorly on the last part of the test, involving a shift in sorting, usually from circles and squares to hollows and solids. More diagnostic of the G.P.I. group are mistakes in the first two parts of the test, involving the ordering of the field and the initial conceptualization of the material. Only three normals make more than two trivial errors in these two parts, and that these errors are determined by attitudes rather than by inability is shown by the fact that they all recover in the more difficult third part. Thirteen G.P.I.s, however, accumulate significant error scores in these first two parts, and all of these deteriorate still further in the third part. These thirteen are in fact the more deteriorated of the G.P.I.s.

On the whole, serious disturbance on this test among normals and neurotics does not occur above S.G. V. But extreme shift difficulty does occasionally occur even above the median. Here it may be interpreted as a personality trait.

Provision was made in the test procedure for a separate account of the ability to verbalize the basis of performance. Among normals and neurotics, errors on this count are trivial, but twelve of the G.P.I.s display the trait significantly. These are not the more deteriorated patients, since the gross performance failure of the more deteriorated group does not enable failure to report adequately on successful performance to be noted.

To sum up, on a background of low scores generally, the specific parietic signs are:

(a) *Difficulty over initial conceptualization*—more than two successive performance errors on the first two parts without improvement in the third.

(b) *Verbalization difficulty*—more than two trials required to report adequately on a successful sorting performance.

(5) *Form Colour Sorting Test*.—This test, used in conjunction with ambiguous shapes, proved the most diagnostic test in the battery. On the basis of it alone it is possible to effect a far-reaching separation of the G.P.I.s from the normals and neurotics. Significant points are:

(a) *Total inquiry errors*: This table of means shows how much worse is the performance of the G.P.I.s when compared with Normals.

#### MEAN INQUIRY ERRORS.

Normals					Neurotics	
S.G. I	S.G. II	S.G. III	S.G. IV	S.G. V	S.G. IV and V	G.P.I.
2.8	3.8	3.6	7.2	7.6	7.9	18.2

Overlap between the G.P.I.s and the other groups is least when a criterion of thirteen total inquiry errors is taken as the separation point:

		0 to 12	13 and over
Normals	...	124	1
Neurotics	...	26	4
G.P.I.s	...	2	23

These normals and neurotics with more than thirteen errors are all low S.G. Vs. There are internal reasons in the test why the break point should occur at this score.

(b) *Shape errors*: While there is considerable overlap between the G.P.I.s and the other groups with respect to the number of errors made during the inquiry into the colour sorting, the situation is quite different with respect to shape. The number of errors made by normals in their colour sorting may become excessive, but to make more than four errors in the shape sorting, out of a possible sixteen, is quite unusual among normals and neurotics, but is the rule among G.P.I.s:

		0 to 4	5 and over
Normals	...	121	4
Neurotics	...	29	1
G.P.I.s	...	6	19

(c) *Shift trials*: It was pointed out that considerable shift difficulty occurred among normals and neurotics as well as among G.P.I.s on ambiguous shapes, frequently at low levels of intelligence, occasionally at high. But with normals and neurotics there is a generalized transfer effect through learning from this test, so that by the time the Form Colour Sorting Test is reached, there is a marked reduction in shift difficulty. With the G.P.I.s, on the other hand, there is not only no transfer effect, but a positive interference from the new element of colour. Their performance with respect to shift becomes worse; most normals and neurotics shift immediately in the first trial. After three trials, special prompting techniques were introduced to induce shift. Almost no normal or neurotic needed these techniques, but most of the G.P.I.s required them, and sometimes nothing that the experimenter could do produced a shift.

		3 Shifting in trials or less	Needing special procedures
Normals	...	119	6
Neurotics	...	25	5
G.P.I.s	...	4	21

The three criteria discussed above (a, b, c) form the major frame of reference for assessing performance on the Form Colour Sorting Test. There are, however, several additional significant points:

(d) *Atypical shape errors*: Among normals and neurotics, almost all the shape errors are confined to three items of the inquiry. In eight items no errors occur at all above the median. Among G.P.I.s, however, shape errors are heavily distributed through all the inquiry questions. Even those G.P.I.s who do not make many shape errors usually make errors in the items in which normals do not. It is therefore possible to consider the pattern of shape errors apart from the number.

(e) *Atypical colour errors*: One group of three test items in the colour inquiry, concerned with the identification of groups, contains only an odd chance error among normals and neurotics. Among nearly half the G.P.I.s, however, a peculiar error syndrome occurs in these items.

(f) *Counting*: A frequent phenomenon among the G.P.I.s is to count the number of objects when asked to give the number of groups or kinds. A tendency to do this which occurred in two non-paretic subjects was self-corrected.

(g) *Shape failure*: Among the more developed G.P.I.s there was a complete failure to sort shape. This did not occur in any non-paretic subject.

(h) *Colour failure*: More rarely, there was among the G.P.I.s a complete failure over colour. This happened in one neurotic subject also.

(i) *Shift trend*: Among non-paretic subjects, when the initial sorting is by colour, there is no difficulty in shifting to shape. The few non-paretic subjects needing special procedures to induce shift all sorted initially by shape. Among the G.P.I.s, all who sorted initially by colour needed special procedures to induce a shift to shape. Therefore, special difficulty in shifting from colour to shape may be added to the list of significant criteria.

IV.—THE BATTERY AS A WHOLE.—In considering the results as a whole, three levels of analysis are attempted: gross score—a purely quantitative estimate; score pattern—a quantity-quality estimate; qualitative features, the interpretation of which the test technique, in its present stage of development, does not render completely objective. The best

results are obtained when the data are considered from all three points of view. Every effort has been made, however, to bring as much as possible within the scope of an objective approach.

The tests were so arranged that an expected normal answer could be postulated for each test item. Any departure from this expectancy is called a deviation. The results may therefore be considered in terms of deviation score, deviation pattern, and deviation quality.

(1) *Deviation score*.—This is obtained simply by summing deviations over all four abstraction tests, regardless of their type or content. This score is intended to provide an assessment of the present level of functioning without going into the factors operative in determining this level. Overlap between the experimental groups is therefore to be expected so far as the deviation score is concerned, since it was arranged that the normal and neurotic groups should contain individuals of low grade intelligence. These two groups in fact contain seventy-six individuals below the twenty-fifth percentile on the progressive matrices, thirty-six of whom are below the tenth percentile. The results may be summarized as follows:

	DEVIATION SCORE									
	0 to 9	10 to 19	20 to 29	30 to 39	40 to 49	50 to 59	60 to 69	70 to 79	Total	
Normals (all S.G.s)	72	44	7	2					125	
Neurotics (S.G.s IV and V)	6	12	8	3	1				30	
G.P.I.s	—	1	4	3	7	8	1	1	25	

The region of significant overlap is the score-range 20 to 39. Most of the non-paretics scoring within this range are individuals below the twenty-fifth percentile, though not all individuals of low grade intelligence have large deviation scores. Less frequently, individuals at higher levels also have deviation scores which are considerable. Those G.P.I.s with deviation scores above forty are not easily matched by non-paretics outside defective institutions. An attempt to match them against institutionalized defectives was defeated by the extreme difficulties encountered in excluding organic factors from the case histories.

(2) *Deviation pattern*.—The four tests together yield fifteen objectively assessable signs, which have been described in Section III. Pattern analysis based on these signs is successful so far as it eliminates the overlap in the deviation score.

	NUMBER OF SIGNS											Total
	0	1	2	3	4	5	6	7	8	9	10 and over	
Normals (all S.G.s)	112	8	1	2	2							125
Neurotics (S.G.s IV and V)	16	4	5	3	1	1	—	5	3	1	14	30
G.P.I.s	—	—	2	—	—	—	—	—	—	—	—	25

Pattern analysis, therefore, has eliminated overlap except in two cases. With regard to these two cases, there is evidence both from other psychological tests and from clinical reports that these patients were not impaired with respect to the functions measured by these tests. The incidence of seven or more signs in the deviation pattern may be taken as an indication of impairment of conceptual behaviour dependent on diffuse cerebral lesion as distinguished from restriction of conceptual behaviour dependent on low grade intelligence, whether or not this low grade intelligence is disturbed by neurosis.

(3) *Deviation quality*.—Below are listed the more important qualitative features:

(a) *Factors related to tempo*: With the paretics, starting time is over-quick. They tend to begin before the instructions are finished. In sorting tests, the stimulus to behaviour is not so much the instructions as the production of the objects. Thereafter, however, excessive time is consumed before the sorting is complete. It is during this period that the phenomena described below as field confusion and precision compulsion are manifested. Again, response to the verbal questions of the inquiry is over-rapid, but the "equivalence" and "handing" procedures tend to be dragged out. Over-rapid initial reaction time was also marked in similarities and in card vocabulary.

These two temporal aspects of organic performance, rapidity of initiation, prolongation of subsequent execution, are complementary effects of frontal impairment. Normal conceptualization implies the converse, some initial delay during which the appropriate conceptual schema is formulated, with subsequent reduction of execution time.

(b) *Factors related to movement*: Frequently with paretics, during the period of prolonged execution, a trait appears which may be called manipulative displacement. By this is meant that for the parietic the sorting test becomes a motor task in which each object has to be delicately manoeuvred into an exact position. Such manipulative concern, which is of course conceptually irrelevant, is a positive sign of the reorientation of the impaired organism (in Hughlings Jackson's sense). The precision compulsion which

results is qualitatively different from the excessive orderliness displayed by meticulous normal subjects. The precision compulsion of the meticulous normal appears on a background of under-movement, that of the paretic on a background of over-movement. Whereas the meticulous normal makes one conceptually determined arrangement carefully, and stops, the paretic makes a series of arrangements, perceptually determined, which follow one from the other. There is no logical stopping place; sometimes, in fact, he has to be stopped by the experimenter. Over-movement, expressed in a series of changing arrangements, is therefore a positive sign, since it depends on the substitution of a perceptual for a conceptual organization of the field. In the field of overt motor behaviour, it is analogous to the chain associations which appear in Similarities.

(c) *Determination by the total perceptual field*: This is the antithesis of normal conceptual behaviour, which demands the abstraction, the active taking out of a characteristic from the field as perceptually given. In the sorting tests, this demands the segregation of the objects into mutually exclusive units. In the paretics, on the other hand, indications are many that not only are their units not mutually exclusive, but that the positive intention of their behaviour is to design a perceptual whole which takes into account all the characteristics of the field simultaneously. Among these indications are:

(1) Field confusion—an attempt to order the field in relation to one characteristic confronts the patient with an order in another characteristic. A period of confused behaviour ensues.

(2) The most characteristic initial sorting for the paretic group on the Form Colour Sorting Test was a double array in which the objects were simultaneously arranged by colour and shape. They then referred to their shape groups in terms of the internal colour differences and their colour groups in terms of the internal shape differences.

(3) In arrays, the objects, both vertically and horizontally, were kept as close together as possible. Experimental attempts to induce separation failed. For example, the experimenter would ask the patient to place his groups in different corners, but instead, the patient would move all his groups over into one corner.

(4) Shift as shift of position: Shift instructions were frequently interpreted as a request to shift the relative positions of rows in double arrays, or of order in stacks, e.g. "We'll have the yellow outside this time and make a change".

(5) Re-sorting during the inquiry in the Form Colour Sorting Test—sometimes patients who had stacked their objects when asked to indicate what they had done, responded by restacking their objects in the opposite way.

These are some of the characteristics by which it may be deduced that a given sorting performance has been determined by the total perceptual field and that no abstraction has taken place. Among non-paretic subjects, other characteristics of the field than that serving as the basis of abstraction may be present as a ground. In fact, all the indications of extra-conceptual concern found in paretics may be present as subdominant features of normal performance. Complete absence of them, as error scores indicate, is the exception and not the rule. But with the non-paretics, intrusion of concern with the perceptual ground does not prevent the abstraction of a conceptual figure.

(d) *Differences offered as similarities*: The phenomenon of giving differences as a response to a request for a similarity occurs throughout both sorting tests as well as in verbal similarities. It is undoubtedly of basic significance and may be related to a conflict between the perceptual and conceptual methods of organizing experience which may be briefly stated as follows: perceptually, the figure is what is different, the ground what is the same; conceptually, the figure is what is the same, the ground what is different. Faced with a perceptual field, there is a spontaneous and involuntary tendency on the part of the experiencing subject to become organized towards the figure. The perceptual field may be said, therefore, to resist conceptualization, since the differences which are its figures are always and inevitably present. This resistance can only be overcome by a voluntary and deliberate inhibiting of the tendency to organize towards the perceptual figure. This inhibiting will only occur in the interests of a concern with what is beyond the immediate perceptual field. Such concern is not possible without conceptual ability. In this way, the connexion between the higher thought processes and volition may be appreciated.

The extent to which a person is perceptually dominated is the extent to which he is tied to the immediate psychological reality. The extent to which he is able to conceptualize is the extent to which he is able to detach himself from the immediate psychological reality and relate aspects of this to situations not immediately present. If, therefore, the higher thought processes are related to volition, they are no less related to recall. These facts must be borne in mind in interpreting test results which disclose impairment of conceptual functioning. The broader significance of the "differences" phenomenon will indicate

why the technique of these abstraction tests has been based on the ability of the subjects to concern themselves, in face of the differences, with the similarities present in the stimulus material. It is with the abstraction of similarities that the conceptual processes are concerned. Just so far as there is failure to abstract, the conceptual figure (the similarity) tends to remain imbedded in its perceptual ground, and the perceptual figure (the difference) tends to emerge and become the main determinant of the response.

#### V.—DIAGNOSIS ON THE BASIS OF THE TESTS.

(1) *Positive diagnosis*.—If there is a deviation score of more than ten, a deviation pattern of seven or more signs, and if some of the qualitative features of performance as outlined above are definitely present, then a diagnosis of impairment of abstract thinking, dependent on organic cerebral dysfunction, of the type found in G.P.I., is reasonably certain.

(2) *Negative diagnosis*.—If, however, the results of the tests are negative, a diagnosis of organic cerebral dysfunction is not thereby excluded. Some forms of cerebral dysfunction appear to affect the abstractive processes relatively little. The present battery may be used as a check on this point. Four to six signs are cause for grave suspicion; deviation quality in the light of the total clinical data will confirm or reject.

It is likely that in certain cases of mild dysfunction, what has been termed constructive spontaneity of interpretation is affected, although the ability to handle similarities is not detectably impaired.

(3) *Degree of impairment*.—No fine scaling of this is possible with the present battery though broad differences may be discerned. The vocabulary test may assist considerably in assessing the degree of deterioration from previous level.

Additionally, the present results suggest that certain phenomena are characteristic of certain levels of impairment. A concept of accommodation to impairment is introduced in relation to this problem. Some tentative evidence will be presented in the full report in support of this concept, but much more investigation will be needed to establish it.

Dr. M. B. Brody: Most of my investigations on intellectual deterioration were made on subjects with syphilitic, senile, pre-senile and arteriosclerotic dementia, in whom it classically occurs.

The qualities which I believe to be characteristic of intellectual deterioration fall into three groups. Those of the first group comprising slow and incomplete understanding of tasks, impairment of categorical thinking, lack of insight into quality of performance and defective self-criticism, and lack of insight into the test "set" are mainly due to cognitive failure. The next group, mainly due to affective-conative failure, includes poor reaction to difficulty, poor reserve of emotional control, emotional lability and facility, excuses and escape behaviour, guessing rather than confessing ignorance, and failure of integration. The signs in the third group are more of a neurological than psychological character. These are disturbances of memory, perseveration, and loss of speed and efficiency of neuromuscular control.

Some tests are better than others for demonstrating these signs; but an experienced examiner can detect them in even the simplest. I propose to illustrate them with examples given in response to the items of a battery of tests recently devised on behalf of the Royal Medico-Psychological Association for investigating pre-frontal lobotomy. The items are:

(1) *Vocabulary*.

(2) *Paragraph memory*.—The examiner reads a paragraph containing 17 memorizable items. The subject repeats as much as he can. The examiner then tells the subject that later he will be asked how much he still remembers, and again reads the paragraph.

(3) *The Weigl sorting test*.

(4) *Picture absurdities*.—The task here is to detect the absurdity in four pictures. In one, for example, a man is trying to saw a log with an inverted saw.

(5) *Cancellation*.—This is a pure speed test, the task being to cross out all the letters "a" in a standard paragraph as quickly as possible for one minute.

(6) *Verbal absurdities*.—The examiner reads eight statements in which the subject must detect the absurdity; for example: "A man had influenza twice. The first time it killed him, but the second time he got better quickly."

(7) *Picture recognition*.—The tester exhibits 12 postcards for three seconds each. He then shuffles them with 12 similar cards and exhibits the lot. The subject has to distinguish the previously exhibited and not exhibited cards.

(8) *Proverbs*.—The task is to interpret 4 proverbs, for example: "Let sleeping dogs lie."

(9) *Delayed recall*.—In this item, the last of the battery, the subject recalls as much as possible of the paragraph read in the second item.

In addition, immediate memory span is tested by having the subject repeat after each

item two groups of digits of from 4 to 9 numbers, and one sentence of from 12 to 26 syllables.

All the qualities displayed by demented subjects are sometimes shown by normal persons and by non-demented psychotic patients of all kinds. What characterizes intellectual impairment is the frequent and intense display of these qualities by a satisfactorily co-operative patient free from invalidating disorders of mood or of the stream of thought, in tests well below the level of his pre-morbid capacity.

A first essential, therefore, is an estimate of the pre-morbid capacity. A quick and simple guide is the vocabulary performance, for it is well known to correlate highly with intellectual level, and to be least attacked in dementia. In the R.M.P.A. battery, an adaptation of Terman's 1916 test is used. The task is simply to explain the meanings of words read by the patient from a list, a mental age being calculated according to the number of words passed. The adaptation doubtless sacrifices some accuracy to brevity; but it remains accurate enough to indicate the quality of performance one may reasonably expect.

*Slow and incomplete comprehension of the task* is revealed on many of the items. In the vocabulary test, whereas normal persons need only the briefest instructions and one or two illustrative examples, the intellectually deteriorated patient needs long and repeated explanations and example after example. Sometimes he has to be reminded of the task after every word in the list; otherwise he merely reads the words believing that to suffice. Often he omits words and loses their place in the list. When asked to start at number so and so, he may have to be shown it before he can find it although the words are listed in numbered order. In repetition of digits, inadequate comprehension leads to attempts to repeat each separate digit as the examiner gives it before the sequence is completed. Sometimes, the first verbal absurdity is repeated as if it were an item for sentence memory. Sometimes the proverbs are treated as verbal absurdities. In the cancellation and recognition tests too, instructions must be carefully, slowly and repeatedly given before they are grasped. The Weigl test, and, in part, interpretation of proverbs, are exceptional in that, as Hanfmann and Kasanin (1942) said of the Vigotsky test, the problem must be solved before it can be fully understood.

As Major Trist has demonstrated, *impaired categorical attitude* can be revealed by the Weigl test. Other items provide more subtle evidence of it when the Weigl test is passed. In the vocabulary test, restriction to concrete modes of thought produces a disproportionate number of definitions not in general terms, but by quoting the word in just one context, or by describing just one situation with which the word is associated. Thus, in dementia, "forfeit" is nearly always defined as a Christmas game, "insure" in relation to burial, "conscientious" as in "conscientious objection", "regard" as in "kind regards", "rambler" as a rose, "quake" as in "earthquake" and "southern" as a railway. The significant point is that the subject, having particularized, is unable, in reply to further questions, to dissociate the word from its special usage. Definition of "priceless" as "worthless" also often arises from impaired categorical attitude, but in a rather different fashion. Here it is the physical appearance of the printed word that dominates the patient.

Failure of categorization also appears in verbal absurdities. The patient, unable to abstract the essentials from the data and deal with them on the abstract plane, fastens on to one concrete element and bases on it a real-life picture which he then deals with as such, neglecting the other elements of the data and their interrelationships. Here are some examples. "A man said to his friend: 'I hope you live to eat the chickens that scratch the earth on your grave'", answered by "You don't keep chickens in a graveyard"; "In the year 1915, many more women than men got married in the British Isles", answered by "That's right. A lot of men were out of the country"; "One day we saw several icebergs that had been entirely melted by the warmth of the Gulf Stream", answered by "The water wouldn't be warm enough".

Failure in interpreting proverbs often arises, likewise, because the patient can conceive the situation described in the statement only in a concrete uncategorical fashion. "You can't make a silk purse out of a sow's ear" is literally expanded by the answer "A sow's ear isn't made of silk". "The mouse that has but one hole is easily caught" is explained "If he had another hole, he could get out that way". "What does it mean in general?" one asks. "Does it refer only to mice?" "Oh no", is the reply, "It could mean rats!"

The next sign in the first group, *lack of insight into the quality of performance and defective self-criticism*, indicates failure of the highest discriminative powers. Here too, the responses to the vocabulary, absurdities and proverb items, as well as behaviour in the Weigl test, are most useful. Replies such as those already quoted are given without sufficient reflection, without judgment, without attempted inhibition, and without realiza-

tion of their inadequacy. This sign is closely linked with the next—lack of insight into the test set—and with emotional facility.

*Lack of insight* into the test "set" is the most subtle of the qualities mainly attributable to cognitive impairment. Most normal persons, as soon as the examination is started, adopt, more or less consciously, an appropriate attitude or "set". They regard the problems simply as problems with no importance in real life. They realize that it is useless to deceive the examiner. They have a sense of fitness. In all these, intellectually deteriorated patients are defective. In the paragraph memory test, for example, as the story of the fire or flood is read, they will often comment: "How shocking!", or "What a shame!", even "I remember hearing about it". Most significant are comments like: "What a catastrophe!" or "How calamitous!" or "How disastrous!", for something is clearly wrong with a subject to whom such phrases spring naturally but so inappropriately. Similar gratuitous comments are sometimes made on the sentence memory items. Recently, on a wild winter's day, I tested the once very intelligent wife of a high naval officer, now suffering from the effects of an old head injury. She achieved a maximum vocabulary score, but after repeating "The cricket match yesterday was won in the very last minute", she remarked "I didn't know there *was* a match yesterday". Some of the longer sentences consist of two clauses. Normal persons, sensing that a sentence as short as the first clause would not occur so far down the list, wait for the second half. Dements, lacking this sense, often start their repetition as the voice drops at the pause. Such lack of test set is especially significant when the subject succeeds in repeating the whole sentence, for span of this length is possessed, with rare exceptions, only by persons of once superior intelligence. The vocabulary test again provides examples. Intellectual deterioration is strongly suggested when a person who ultimately scores highly defines "Mars" as a kind of chocolate and "snip" as something good for the 3.30.

*Guessing*, the last sign in the first group, also illustrates lack of insight into the test set. We all guess at times, but repeated insightless uncritical guessing by persons who should know better is significant. Guessing occurs on all items, but once more the vocabulary test is the most fruitful. One may, however, be misled by manic flight or schizophrenic dilapidation. It was a schizophrenic who defined "laity" as a song—a baffling definition, until she explained "Like in the song 'Yodel-ay-i-tee' ". Guessing is also obvious in repeating digits and sentences.

The second and third groups of qualities can be dismissed more quickly not because they are less important than the first group, but because the signs are more easily described and are familiar from their occurrence in other than test situations. First of the qualities attributable to affective-conative impairment is poor reaction to difficulty. Indeed, all the signs in this group may be brought under this heading. Difficulty normally engenders extra effort. In dementia, it exposes weakness of emotional control, and results in feeble surrender or excuses and escape behaviour or emotionalism or collapse of integration, or all of these at various times. Poor reserve of emotional control appears particularly in the cancellation, picture recognition and paragraph memory items. As the tests inexorably lengthen, heaving sighs, tighter or fidgety change of grip on the pencil, shuffling on the chair or of feet, or other similar actions recalling the behaviour of a too-long-lectured audience, become frequent. The initial level of performance is not sustained. Errors, guesses and requests for reassurance and guidance with agitation when these are withheld, increase, although the task does not become harder.

*Emotional lability* appears on all the items as a tendency to become unduly distressed by failure and elated by apparent success. Facility is indicated by the ease with which the examiner can flatter the patient into believing even grossly inadequate responses to be excellent. Excuses and escape behaviour also are seen at times on every item. "It's a long time since I went to school", "I'm too old for these childish games", "I've got a bad headache", or "I'm very worried just now", are favourite complaints. Uncritical egocentricity lies behind these excuses—the subject is unwilling to admit ignorance. Sometimes this appears undisguised as boasts of former prowess. Guessing partially springs from this cause. Some patients guess so uncritically in the sentence memory test that they produce mere jumbles of sound approximating the original but without structure or meaning.

*Failure of integration*, the last of the affective-conative signs was originally described by Earl in maladjusted morons. A normal person, when tested, keeps reasonably cool. He becomes neither over-excited nor over-inhibited. He keeps his head, to use the layman's phrase, or, to use Earl's word, he remains "integrated". He becomes neither a bull in a china shop nor a rabbit in a snake park. The dement may become either or both. The cardboard figures of the Weigl test may be handled either too timidly or too excitedly. In the cancellation test, excessive speed or excessive caution may be shown in scanning the lines or making the strokes. By no means uncommon and particularly significant is behaviour fluctuating between both extremes.



In the last group of qualities, those of a more neurological than psychological character, *memory defects* are the most obvious. They are displayed in the sentence and digit spans, the paragraph memory tests and in recognition of pictures. They are objectively recorded as omissions, errors and alterations, and need no further description.

*Perseveration* can be beautifully demonstrated in the vocabulary test, often when it would be overlooked in everyday conversation. Instead of defining the word, the subject perseverates it, for example, "*Tolerate*"—"That's tolerate . . . when there's someone you can't tolerate". "*Priceless*"—"When something is priceless . . . you want it and it's priceless". In the Weigl test, subjects may perseverate the same faulty grouping over and over again. In digit span, a number may release a perseveration of a well-known sequence such as 5, 6, 7, 8. Occasionally material from one verbal absurdity or proverb may become involved, because it is perseverated, with the material of a later item in the test.

Last of all, *loss of speed and efficiency in neuromuscular control* is revealed in cancellation and in the Weigl test. It can be easily distinguished from the inactivity of inhibition and the inertia of retardation. The subjects know what they want to do, but are slow, feeble and inaccurate in performing it. They grip the pencil clumsily, their pencil strokes through the "a's" are slow, laboured, irregular, crudely heavy, or faint and broken. They pick up and move the Weigl pieces slowly, jerkily and clumsily, often dropping them. Sometimes mispronunciation in the vocabulary test appears to arise in a similar fashion, as it certainly does in some paretic and senile dementes.

### CONCLUSION

For diagnostic purposes these signs need more than observing and recording; they need to be evaluated. At times, they are displayed by normal persons of even the highest intelligence. They suggest abnormality only when repeatedly and intensely displayed on items well below levels at which the patient, were his pre-morbid capacity unimpaired, should easily succeed. Even so, the abnormality may be almost any psychiatric condition. Further interpretation demands psychiatric as well as psychometric experience; for now all the rest of the clinical picture and data concerning the patient must be considered. Where, however, the subject is co-operative and free from disorders of mood or of the stream of thought, and where the history and clinical findings substantiate the diagnosis, the qualities of mental test performance I have described, judiciously assessed, are, I believe, reliable indices of intellectual deterioration.

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## Section of Medicine

President—GEOFFREY MARSHALL, O.B.E., M.D.

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### DISCUSSION ON FUNCTIONAL NERVOUS STATES IN RELATION TO SERVICE IN THE ARMED FORCES

Lord Horder: I shall deal with this subject largely from the angle of the Medical Recruiting Boards. The function of these Boards is to provide men for the fighting services who are physically and mentally fit. Two facts are important: conscription, which was introduced at the outbreak of the war, and the urgent demand for man-power.

The Civil Medical Boards were not concerned with posting. This is often not realized. *Vide Lancet* of May 4, 1940, where a leader opened by the words: "those responsible for recruiting cannot claim to be doing everything possible to ensure economy and efficiency . . . while pegs that are . . . square are being put into round holes." In another leader on February 21, 1942, a more proportionate view is taken . . . "Doctors have enough experience of the wide range of what is normal and healthy to abstain from rejecting men who have a defect that had not interfered with active civilian life . . . it would be a sorry thing if examining Medical Boards assumed that the Services could only utilize men with the equipment of mind and body required, for example, by an R.A.F. pilot or a member of the Royal Armoured Corps".

The responsibility of grading rests with the members of the Board and a man's grading must be determined at as early a stage as possible consistent with reasonable accuracy. To accumulate blocs of men and women awaiting final disposal would greatly encumber the machinery of recruitment.

The material presenting itself before the Boards is more heterogeneous as the result of conscription than was the case in the days of voluntary service. The approach is made from three points—physical, constitutional and psychological. The overlap between the approaches is obvious. Physical defects are easily detected; constitutional defects are more difficult. Medical Boards are enjoined to consider "the general condition and physique" in every case, but in the absence of any criteria of what Alvarez has called "constitutional inadequacy" it is very difficult, in the thirty minutes at their disposal, to do much about it. It requires large experience to say of any particular man that on grounds of his physique alone he will not make good in the armed forces. If encouraged to do much along this line Boards would probably have put Nelson in Grade IV. "His nervous system was always frightened but his awareness knew no fear."

In an inspired leader in *The Times* of March 5, 1942, on "The Mind of the Recruit" the writer says that the "chief business of a Medical Board, like that of a practising physician, is prognosis". Surely the chief business of both is diagnosis with a view to prognosis. That the mind of the recruit, no less than his body, determines his fitness for service, is not challenged; nor that "trustworthy conclusions about the mind . . . are difficult to reach . . . in the limited time available". But a special examination of every recruit's mind by a psychiatrist has not been considered to be in the general interest. Nor has it been thought helpful in the identification of psychoneurotics to ask the recruit to answer a questionnaire before examination. The Advisory Committee was anxious to avoid "snap" diagnoses on the one hand and the making of nervous invalids on the other. The danger of creating and of spreading doubts and fears and anxieties by delving into the personality of the recruit during a rapid and necessarily direct inquiry was not to be underestimated.

Then there was the suggestion that recruits should be asked the degree of their willingness or unwillingness to serve; so that the unwilling ones might be posted to a special training centre. This, too, was not accepted, because it seemed to raise a good many issues which lay outside even the psychiatrist's brief. Let us face the question squarely. How many men would not, in the language of the prize ring, "pull their punch", if dealt with by methods like this?

So-called "errors" in grading are to a certain extent inevitable: some five million men have passed through these Boards since war began: but on the basis of the examination

which the Civil Boards are required to make, the proportion of men passed as fit for service and found later to be unfit has been very small. I say "on the basis of the examination which the Civil Boards are required to make", because if this basis is a different one for passing as fit and for discharging as unfit, and if the needs of the armed forces as understood by the Advisory Committee of the Civil Boards and those accepted by the armed forces themselves do not harmonize, then, clearly, considerable anomalies will arise. And in the first and second years of the war considerable anomalies did arise.

During one particular six months towards the end of 1941 an average number of some 1,300 men per month were discharged from the Army on account of psychoneurosis, many of them within a few months of enlistment. Many thousands of men have been thrown back into civil life (where they had previously made good), and this fact was read as an indictment upon the work of the Civil Medical Boards.

Turning now to the actual Army requirements. There is little doubt that it has taken the authorities some time to discover the extent, and nature, of their needs. This is but part of the inevitable lag in the development and expansion of the Service and the consequent disposal of its personnel. The steady upgrading of Army duties as the result of mechanization has left much of its personnel relatively out of breath. It has been estimated that 5% of all recruits are unable to learn the duties of the modern soldier, and another 5% can only do so if trained in special squads (Esher). In return for the criticism of the Civil Medical Boards that they did not turn down men because they were unlikely to be up to the standard required, the Advisory Committee pointed out that it is not in its reference to post men to particular duties but that it did seem very desirable that "all practicable steps should be taken to secure the allocation of men to different branches of the Army and to duties suited to their capabilities". The Committee pointed out that careful posting not only salvaged man-power, it minimized the risk of those very breakdowns which the psychiatrists feared—an example of a general principle in the treatment of psychological inadequacy.

The introduction of simple intelligence tests intended to facilitate suitable posting naturally received the Committee's blessing. More than that, the Committee drew attention to the obvious disadvantages of discharging any recruit unless it is clear that his physical or mental state renders further Army employment impracticable. The new policy of sending all recruits to general service Corps and to primary training centres for examination and posting is the proper answer to the difficulty and this has been implemented.

The first duty of a soldier is to learn endurance. This may be quite foreign to his nature or to his previous environment. He may hitherto have been a parasite upon society, as most neurotics are. He must now largely lose his individuality, he must accept discipline, he must forgo much of his privacy, he must submit to many, and gross, personal inconveniences. But he should be given a good trial of his capacity for adjustment to these new things, of his ability to become extravert in his behaviour. If he is discharged before he gets this chance a great disservice may be done to him, as well as to the community.

This is being slowly realized. The new Q Sections are proving a success. Men with mental ages of 6 or 7 are doing useful work in these sections. They realize they are doing work of national importance and doing it well.

The Directorate of selection of personnel has developed rapidly. An account of this by C. S. Myers appeared in the *Lancet*, 1942 (ii), 491. It is to be hoped that the pendulum may not swing too far in this new direction, giving the exponents the notion that mental tests have established permanent criteria. Raven points out that the reaction of neurotics to mental tests is very unreliable since they record an activity which varies with health, with incentive and with immediate and remote distractions. And Myers reminds us that tests of personality are far less reliable than tests of aptitude. Since personality counts for so much in soldiering, especially in the officer group, the warning is opportune. Character and temperament, integrity and sociability elude our tests much more than does mere intelligence; and unless we give "intelligence" a very limited definition much of it eludes them also.

**Surgeon Captain Desmond Curran :** The problem of functional nervous states in relation to service in the Navy necessarily differs from that in the other Services. It is of course true that the Navy has on the whole been subjected to more prolonged and severe stress than has the Army or the R.A.F.—with the exception of its flying personnel. But the increased incidence that might be expected to result from this is probably more than counterbalanced by the quality of the men who were in the Navy before the war or who have subsequently volunteered or expressed a naval preference when called up. To be

a volunteer produces an initial selection of great value (although some do so for mistaken reasons such as the hope that the fresh air will be good for their nerves); and since more men have always wanted to join the Navy than could be taken, the opportunity has existed for a further selection from an already highly selected group. Again the expansion of the Navy has been relatively much smaller. The only reasonable inference is that the problems in the three Services are not really comparable. We have, for example, a much easier task than that which confronts the Army.

*Organization.*—This is based upon certain principles. Firstly, that neurology and psychiatry should be regarded as two aspects of one subject closely linked with general medicine. Hence, our neuropsychiatric units have been formed, as far as possible, as an integral part of the main naval hospitals. A close association with general medicine and surgery can be to the advantage of all concerned. The great danger for psychiatry is to become a special cult; the great danger for a special psychiatric hospital is to obtain the reputation of a "looney bin" the entry to which is a prelude to invaliding; and a great danger for general medicine is to neglect the psychological aspect of illness which assumes such increased importance in war time.

The second principle is that of the necessity for early treatment, with special emphasis upon the avoidance of hospitalization. One of the most important functions of a neuropsychiatrist in war time is to decide what cases do not need hospital care. Hence, out-patient centres have been instituted in the main naval depots through which men pass before draft.

Thirdly, it was considered essential to try to reduce to a minimum the incentive to "escape" by the development of an illness. The neuropsychiatrist is constantly confronted with the dilemma whether to put a man on duty who is liable to prove unsatisfactory or to crack, or whether, by invaliding such individuals, he is making escape too easy and thus creating a bad precedent. Hence, a special rehabilitation unit has been formed. The main value of such a unit is the imponderable one of prophylaxis in providing an incentive to certain men to face their personality disabilities and defects; but there can be little doubt about its immediate value at all events for a number of the men who have been sent there.

Finally, some steps have been taken to deal with the most important subject of all, that of pre-selection.

*Numbers.*—In view of the continuous stress to which the Navy has been subjected, the problem of functional nervous states has been a small one; but from the medical standpoint, the problem has been a substantial one.

From our experience, we would suggest that 10% to 15% of the beds of a large hospital should be set aside for neuropsychiatric cases.

*Etiology.*—War stress, in the sense of direct experience of enemy action is not, of course, the only cause of breakdown in war time. Removal from home and previous ways of living, the restrictions and regimentation of Service life, and domestic problems, are obviously the important factors in a large number of cases. Sexual factors play only an insignificant part.

*Types of reaction.*—Gross conversion hysteria (paralysis, mutism) is very uncommon. It was also uncommon in the Navy in the last war. Most of the cases we see show affective reactions, i.e. states of anxiety and depression combined in various proportions; but they are usually complicated or prolonged by hysterical or escape mechanisms. It can be said in crude terms that the better type of man struggles on until he has developed an affective reaction of some intensity; whilst the less tough either develop a "purely" hysterical condition or succumb to quite minor affective symptoms. This difference is well shown in the figures from one neuropsychiatric unit, where hysteria as a primary diagnosis was made in 15% of the ratings admitted and in only 4% of the officers.

Mental deficiency as a primary diagnosis has accounted for only some 5% to 7% of all neuropsychiatric cases seen. A very low level of intelligence as judged by tests is compatible with apparent efficiency in such branches as ordinary seamen or stokers so long as the men are stable; a mental age of 9 years plus (Kent Oral) does, however, appear to be the lower limit. An intelligence test score is of course only one item of information in the diagnosis of mental defect, and the stability of the individual often possesses greater practical importance. The wisdom in labelling or dogging men with intelligence test results therefore seems to be most dubious.

Psychosomatic manifestations are very common. "The nerves go to the stomach" with special frequency or show themselves in the form of headaches. "Effort syndrome" is rare but is showing signs of increase mainly amongst Marines who are called upon to march. Various ocular manifestations are rather frequent. The low incidence of

hyperthyroidism is a matter of some surprise for the precipitation of a fair number of cases by severe stress might have been expected; but it has not happened.

*Results.*—A striking psychiatric lesson of war time is the extent of personal adaptability. In one representative depot it has been found possible to keep about 90% of the new cases seen at some form of duty; the remainder are either invalidated directly or are referred to hospital. But post-concussional cases do not do well. As regards in-patients, in one neuro-psychiatric unit about 75% of admissions were sent back to some form of duty. The average duration of stay was just over three weeks for those returned to duty, and just over four weeks for those invalidated. So far as is known the relapse rate is surprisingly small. On the whole a better type of man is being seen as the war goes on. Thus in one depot over half the new cases seen had been in the Navy for over two years. But the major part of our clientele is, and always has been, composed of men who are "King's hard bargains". Many have never been to sea at all. The results quoted above may seem good, but many we have sent back to duty are doubtful assets to the Navy. We would have invalidated more had it not been for the question of example to others. The high wages to be earned in civilian life add greatly to the difficulties.

*Pre-selection.*—The matter of pre-selection is therefore of fundamental importance to Service psychiatric work. How effective good selection can be is well shown in the case of submariners amongst whom the breakdown rate is negligible. A careful selection for all men entering the Navy is obviously desirable, but how far is it possible?

Difficulties have arisen partly because the Ministry of Labour Medical Boards and the fighting Services are to some extent at cross purposes. The function of the former is to assess a man's fitness for some form of National Service; it is not their function to decide what form that service should take, and still less, for example, to decide that a man is fit for the stress of service at sea. Moreover, much emphasis is laid by these medical boards upon the obligation, and stringent precautions are taken to ensure that men do not evade their duty by "feigning" illness. No one desires that the lot of the shirker or the scoundrel should be an easy one; but equally, no one would desire such individuals as members of a ship's company.

From the naval point of view the following quotation from an official circular to recruiting boards in the U.S.A. expresses the situation admirably:

"The Army . . . is in no sense a social service or a curative agency. It is to be considered neither a haven of rest for wanderers, nor a corrective school for misfits, ne'er-do-wells, feeble-minded persons or chronic offenders. Furthermore, it is neither a gymnasium for the training and development of the under-nourished or undeveloped, nor a psychiatric clinic for proper adjustment of adult emotional development. Therefore there is no place in the Army for physical or mental weaklings, potentially psychotic or pre-psychotic persons or those with behaviour problems. Men who present behaviour problems in the civilian community will certainly present intensified problems in the Service."

An attempt has been made in the Navy to remedy some of the present defects in selection. A number of men are passed Grade I medically who are not Grade I from the psychiatric standpoint. The standards to be adopted for acceptance must depend upon the excess of the supply over the demand and the efficiency of the selection procedure. The other limiting factor is that certain men are not worth taking at all no matter what the man-power position may be. As it was obviously impossible for every man to be seen by a psychiatrist, it was necessary to try to design a system to pick out men who should be subjected to a further psychiatric scrutiny. Carefully selected and trained members of the W.R.N.S., supervised by psychiatric social workers, have been used for this purpose. They check up the forms which all naval candidates at recruiting centres must now fill up about their work record and kindred matters, and ask certain additional questions bearing on stability. This system has been in operation for over a year but for various reasons it has only quite recently been possible to judge of its value. It seems to be an efficient method of doing what it set out to do, namely of indicating what men should receive further individual examination. It has been found that the proportion of men entering the Navy showing anything positive is very small.

The incidence of functional nervous disorders is largely dependent upon factors quite outside medical control. The Navy is singularly fortunate in this respect in its traditions and high morale and in the quality of its officers and petty officers. These factors enormously ease the burden of those who have the privilege of working in the Naval Medical Service.

Brigadier J. R. Rees: The Royal Society of Medicine's discussion in April 1941 (Section of Psychiatry *not published*) on the possibility of prediction of breakdown, along with

many published surveys of military patients in hospital, makes it appear that a minimum of 30 to 40% of these cases might have been predicted beforehand on their histories. One of the best and most practical comments made was Dr. Minski's letter to the *Lancet* of September 27, 1941, p. 382.

We know from experience of the last war and of this that mild neurotic tendencies are no bar to service and that many men and women with definite neuroses do well: e.g. those suffering from anxiety, well-controlled, and from obsessional conscientiousness and drive. Many eccentrics do excellently, as might be imagined.

There is no accurate method of forecasting who will break under prolonged physical and mental strain. On a small scale the experience of the last war has been repeated in Norway, France, Libya and Crete.

We do, however, know from past and recent experience that certain men do badly and are poor risks:

(a) Those of low intelligence with evidence of instability shown in a bad medical and occupational record.

(b) Those with a bad record from childhood and adolescence, shown by: (i) Frequent "gastric" and "rheumatic" symptoms. (ii) Effort syndrome type of symptoms. (iii) Breakdown without obvious cause. (iv) Short-phase cyclothymia. (v) Overscrupulous self-drive without insight or humour. (vi) Paranoid psychopathic personality. (vii) Shiftless overdependence with bad work record.

Many men should therefore be detected, and they are better left undisturbed in industry, so avoiding unnecessary dislocation of individuals and the community. The morale of the forces suffers always when men have to be discharged fairly soon after admission, and this is a matter of the highest importance.

While the Recruiting Boards have done, and are performing, excellent work with their present facilities, it is worth recalling some of the suggestions previously made:

(1) That a questionnaire should be used, such as that produced by Dr. John Rickman at Wharnccliffe Hospital, Sheffield.

(2) That whatever the difficulties, National Health Insurance and school medical records should be produced for each man and they should be instructed to bring letters from their private doctors.

(3) Police records should be available where such exist.

(4) More time should be available for the Board since it is impossible to take a thorough history or make an adequate judgment on many cases in the time at present available.

(5) Doctors from Recruiting Boards should visit Service Units so as to have a satisfactory orientation and awareness of the needs of the modern Services.

The Army gets the bulk of the "psychopathic tenth" who come into the Services and despite the many efforts to employ men suitably in their own Units or through special postings to limited service of various kinds, there is a very high invaliding rate.

It is greatly to be hoped that there will be still better co-operation between the Services and the Recruiting Boards, and that from now to the end of the war there will be steady improvement in our knowledge of the requirements of the Services and in our combined medical contribution to the war effort.

**Group Captain R. D. Gillespie:** The psychiatric observation from which has evolved most that is of value in war psychiatry is the importance of predisposition. It bears on the whole psychiatric policy in the Services, not only on the problem of the care of those who have broken down, but still more on the preventive aspect—the care of personnel before they break down, and, above all, selection.

Whether the predisposing or constitutional factors are inherited or acquired is hardly of practical importance as far as this war is concerned, since there is not time for the employment of the technique of psychotherapy that would remove factors acquired in very early life.

Some statistics will illustrate the importance of predisposition: Out of 251 flying personnel who broke down 150 or 60% showed predisposition of at least a moderate degree; out of 256 ground personnel who developed psychoneurotic ailments 222 or 87% showed a degree of predisposition which varied from "considerable" to "severe". The difference between the two groups in severity of predisposition is what might be expected in flying personnel compared with ground personnel.

The fact that pre-existing factors are so important does not mean that psychotherapy itself is useless. In so far as psychotherapy is practicable it has to deal with the reaction to the contemporary situation in most cases. In this connexion a distinction should be made between "war" neurosis in general and "battle" neurosis. The majority of published descriptions of treatment of an analytic kind, which are anyway few, show

that the cases involved are not so much "battle" neuroses as neuroses depending on circumstances other than those of combat, such as separation. By employing, however, a superficial type of psychotherapy for the "battle" neuroses results are obtained which are not altogether unsatisfactory; but again the factor of predisposition stands out. In one group of 50 individuals 14 or approximately 28% were found to have been regarded as fit for full duty when the results were inspected two years later. In a second group of 52, 30 or just under 60% were found to have been passed for full duty when results were inspected at least a year afterwards. The difference between the two groups was almost entirely accounted for by the greater predisposition of the first group who had broken down much earlier in the war.

*Prognosis.*—The previous personality and amount and kind of predisposition is of foremost importance when forecasting the results of treatment. It is interesting to note that in the first group at the time of discharge from hospital the estimate was formed that 25% of them would return to full duty; this was just under the actual number when investigation was made of the results two years later. In the less predisposed group the estimate at the time of their discharge was that just over 50% would return to full duty, and in fact, the ultimate figure was 60%. The correspondence is very close and the prognosis was based almost entirely on estimates of the amount of predisposition.

It follows from all this that probably the most useful contribution that psychiatry could make would consist in improving methods for detecting predisposition beforehand, i.e. in methods of selection. It can be said that there is reason to hope for improvement on the present methods, thus avoiding wastage in training.

There are two fundamental aspects to which psychiatry may help to make a contribution—in the field of intelligence, in collaboration with the psychologist; and in the field of temperament, in which psychiatrists have unique qualifications. Their daily life and work is mainly with problems of temperament, i.e. with qualities that more than anything else determine an individual's success or failure in life.

*Intelligence.*—No one should be rejected on a group intelligence test alone. It must be supplemented with an individual test in every case in which there is a prospect of rejection on account of a low score on the group test. Factors likely to produce a low score in a group test, apart from intelligence, are lack of interest, emotional stress, unfamiliarity with paper and pencil tests, educational defect and age. The psychiatrist's job in connexion with group intelligence tests is: (1) To ensure that no one is rejected on a low score without an individual test and a considered assessment based on that. (2) To see that the recruit is stable—the most important requirement of all. (3) To ensure that he is placed in an appropriate general type of job in the Service, i.e. one compatible, as far as possible, with his intellectual and temperamental qualities. It is extremely improbable that there ever will be a group test that will enable us to dispense with individual examinations as to minimum fitness for a Service.

*Temperament.*—Group tests are of little or no value here. In fact tests of any kind, even individual tests, are of little account in this field. The psychiatric type of history is the foundation of assessment of temperament. It, however, can be reinforced by special techniques such as the Rorschach method, and by other "projection" tests. One of the chief arguments against the use of the psychiatric method seems to be that the stress of war brings out unexpected qualities in some individuals who would almost certainly be rejected by psychiatrists. The answer to this is twofold: (1) That individuals mistakenly excluded from commissions and other duties by psychiatrists will still have a chance of proving their worth in the traditional way—in the field; and (2) that the individual regarded as potentially poor stuff by executive officers or doctors other than psychiatrists, is often regarded differently by the psychiatrist from his angle. On the other hand the speciously promising type, often regarded superficially as "keen" is liable to be spotted from the outset by psychiatric methods.

The arguments for psychiatric and psychological selection for (a) Service in general of any sort; (b) combatant duties; (c) technical duties, and (d) commissioned rank—all of which different functions necessitate the possession of different good qualities and the absence of other detrimental characteristics—are briefly these: (1) The orthodox methods are unscientific and not fully efficient, and there is wastage in consequence of this; (2) the use of psychiatric methods of selection for special jobs or for service of any kind does not preclude subsequent selection along the old lines of trial and error in the field; (3) the degree of intelligence a candidate possesses can be fairly accurately assessed, and those who from lack of intelligence or lack of opportunity for education are incapable of fulfilling the necessary conditions can be eliminated, either completely if they are defective, or from skilled jobs or posts of responsibility if they lack the necessary degree of intelligence and a suitable temperament; (4) the temperamental aspects are difficult to assess and are the

main cause of error, but experience with those who have failed has shown that the methods and criteria of psychiatry are adequate in the majority of cases to explain why these failures occur. The systematic application of these experiences to the selection process offers the chief hope of improvement in the technique of selection at the various levels in which it is employed.

**Dr. Wm. M. Fairlie :** Two recent official documents indicate that Medical Boards are primarily concerned with physical fitness, but the book of instructions issued to them, clearly and at some length, points out the importance of the nervous and mental states and indicates that cases showing minor defects may be acceptable for service, for there is an instruction to mark them "for observation during training". From the commencement of their work in 1939, Medical Boards have accepted their responsibilities with regard to the nervous and mental states and have endeavoured to carry out their instructions.

Provision is made in the book instructions whereby doubtful cases may be sent to consultants, but it has been found that such cases, sent to psychological consultants, almost invariably, come back labelled "unfit for service".

It appears to be an Army order that all cases marked "for observation during training" must be referred to an Army psychologist immediately on joining up and cases have occurred where, in spite of great care and full investigation by the Recruiting Board before acceptance for service was recommended, the man has been discharged and home again almost within a week.

It seems useless to investigate recruits in an organized and controlled way, as is done by Medical Boards, and later, in the Services and on discharge, apply a totally different reasoning. Let us have some degree of commonsense and have a unified method of working. It must be borne in mind that Medical Boards have a very definite instruction of a different kind, viz. "that no men who are fit will be at liberty to evade their obligation" for service.

The investigation of the past of recruits so that more information about them may be available at Medical Boards could be done by a trained clerk, who would record the complete previous history of the recruit. This is carried out by some Boards in particular cases but, if applied to all recruits, it would enable the Boards to have a truer presentation of each man, whereby it would be possible to place him in one of many more categories of fitness.

Consultants to Medical Boards are chosen by the Boards themselves and approved by the Ministry of National Service. Would it not be better for the Ministry to appoint the consultants direct?

The so-called intelligence test before Medical Boards should be abolished. It complicates the work of the Boards and, once its possibilities become known, it is likely to be the subject of abuse.

With regard to discharge from the Services it is suggested that the advisability of specialists acting on Boards dealing with cases involving their own specialty be considered. The specialist's opinion should, of course, come before the Board but it seems inadvisable that he should act as a member of the Board. No one, however well intentioned, can act as a witness, advocate and judge in the same case.

**Major H. B. Craigie :** Emphasis has been laid upon the large number of recruits rejected by psychiatrists as unfit for further training, and upon the percentage of cases discharged from the Army on psychiatric grounds. It has been suggested that this rate of discharge is too high, and that many men so rejected or discharged would, if allowed or compelled to remain in the Army, ultimately adapt themselves satisfactorily to active service conditions.

Experience gained in the Middle East Force during the last two years does not lend any support to this view.

A strikingly large percentage of the total number of psychiatric cases arising in the Middle East Force during this period showed evidence of severe psychopathic traits in the previous history. These psychopathic traits were not of an abstruse character, nor based upon any controversial psychopathological theory, but were of a fairly obvious and easily recognizable type, which would have been evident in the taking of any careful case history.

In many cases (over 20%) there was a history of serious nervous breakdown in civil life; many patients had previously been patients in mental defective colonies or in mental hospitals; and in many more there was evidence of a bad previous record, of the type described by Brigadier Rees, dating from childhood and adolescence.



These cases represent the type which, during the personnel selection procedure of the General Service Intakes, are referred to the psychiatrist, and for whom the psychiatrist may recommend either some modified form of occupation within the Service, or discharge. The great majority of these cases could be easily recognized and assessed by a Recruiting Board if sufficient time was available to obtain a thorough history, and particularly if further details of the previous history were provided for the Board in questionnaire form.

This group of cases reacts badly to overseas service, or to the prospects of service in a forward area. Many develop a psychiatric breakdown on the voyage, have to be admitted to hospital on disembarkation, and may often have to be returned home without seeing any service at all (36 cases of this type were admitted direct from convoys to one psychiatric centre alone in the second quarter of 1942).

A very much larger percentage break down within a few weeks or months of arrival at an overseas station. It is perhaps important to remember that these cases are obvious not only to the psychiatrist but to other officers—they are often only sent to him as a last resort, when all the efforts of the Company Commanders and Unit Medical Officers have proved unsuccessful. It is clear that the efficiency of any Expeditionary Force must suffer if it includes large numbers of officers and men who, by virtue of their previous histories, are likely to develop a psychiatric breakdown.

The policy adopted in the Middle East Force was to avoid, so far as possible, evacuation of psychiatric cases, and to retain almost all these cases in the Command on at least some form of duty. Duties were readjusted, transfers to different arms of the Service arranged and ultimately a specialized rehabilitation battalion was formed, designed to cope solely and directly with these cases. Although this policy of retention was considered to be justified, and indeed almost unavoidable, under the circumstances prevailing, it presented many difficulties, and it was impossible to escape the conclusion that it would have been very much better for all concerned if they had not been drafted overseas or even, in many cases, not retained in the Army at all.

In conclusion, it is possible that perhaps half of the work of psychiatrists in the Middle East Force would have been eliminated if the present selection procedure had been established earlier.

**Lieutenant-Colonel J. A. Hadfield:** As a practical suggestion—if the Recruiting Boards could adopt the "Annexure Scheme" of the Army, whereby neurotics could be posted for certain civilian jobs in the Army (and could not be detailed for any other work by their Commanding Officers without reference to the War Office), there would be far fewer recruits graded as "unfit for any form of military service" by the psychiatric specialists, far fewer misfits in the Services, and more effective service to the country.

**Major W. R. Reynell:** At the outbreak of this war the Germans had 200 fully trained Army psychiatrists. All the men for Panzer units were carefully "hand picked".

The state of our resources was very different. Only a small proportion of potential or actual psychoneurotics can be seen or treated by psychiatrists. The most profitable means of dealing with the problem of psychoneurotics in the Army is effective treatment at the source—Unit Medical Officers might sometimes take more responsibility for diagnosis and treatment of the "regressive" subject at the risk of missing an occasional "organic" case. Reference to specialists, repeated examination and hospital treatment, often lead to the development of severe psychoneurosis with unfavourable prognosis.

## Section of Laryngology

President—V. E. NEGUS, M.S.

[December 4, 1942]

### DISCUSSION ON THE TECHNIQUE OF RADIOTHERAPY

B. W. Windeyer: The effect of X-rays and gamma rays upon tissues is a destructive one and if a dose of sufficient magnitude is given to any tissue necrosis will be caused. There is, however, a selective damaging effect. Some tissues are destroyed by a smaller dose than are others, and the whole object of radiotherapy in the treatment of malignant neoplasms is to effect the destruction of the tumours *in situ* with a minimum of damage to the surrounding tissues. There is a margin between the dose necessary to cause destruction of malignant cells and that which will cause irreparable damage to normal tissues. The width of this margin is affected by the resistance to radiation of both the cells of the malignant tumour and of the normal tissue. If this margin is wide the neoplastic tissue is easily destroyed while the normal tissue remains comparatively uninjured. In such a case the neoplasm is said to be radiosensitive. If, on the contrary, the margin is small the dose necessary to destroy the neoplastic tissue may approximate to that which will destroy or cause irreparable damage to the normal structures and in these circumstances the neoplasm is said to be radioresistant. The object of all variation in radiotherapeutic technique is to increase the width of this margin as much as possible and so bring a greater number of neoplastic conditions into the radiosensitive category.

Some growths are naturally radiosensitive. Such are lymphosarcoma, lympho-epithelioma and the majority of basal-celled carcinoma. The majority of neoplasms are, however, not naturally so radiosensitive and their successful treatment demands special variations in technique. The variations adopted are mainly of two kinds: (a) alterations in the rate at which radiation is delivered and the length of time over which the treatment is spread, and (b) alteration of the character of the radiation.

The three main methods which have been employed in applying radiotherapy have been: (a) Multiple small dose technique. (b) Single massive dose technique. (c) Fractionated technique.

(a) The first, multiple small dose technique, is of value, and the treatment of choice, in dealing with inflammatory conditions, but should be mentioned in connexion with the treatment of malignant disease only to be condemned, as it has no place in any attempt at curative treatment of malignant neoplasms. The individual suberythematous doses given at intervals of about a week or longer do not have a cumulative effect on the rapidly dividing cells of the neoplasm. Some may be destroyed, but the majority which survive appear, in their successive generations, to acquire progressive immunity to the effects of radiation. The damaging effects on the infrequently mitosing normal tissues are, however, cumulative and there is the risk of causing marked fibrosis or necrosis of the area with active and resistant neoplasm still present.

(b) The single massive dose technique is certainly of value in some conditions, more especially in superficial localized growths which are radiosensitive, such as the majority of the common malignant diseases of the skin. It does, however, cause a very marked reaction both local and general and is not suitable for extensive, deep-seated and radio-resistant lesions.

(c) The fractionated single course of treatment is most widely applicable in the X-ray treatment of malignant disease. It has been found that, owing to the recuperative powers of the tissues, if radiation is spread over a period of days or weeks the tissues will stand a greater dose than if the treatment is given in a short period of minutes or hours. Moreover, it has been found that by spreading the treatment out in this way certain malignant tumours can be destroyed without undue damage to normal tissues whereas this could not be done with a single massive dose. Regaud propounded the theory that by spreading the total period of treatment over a period of several days up to two or three weeks, more malignant cells were irradiated in their most vulnerable stage of mitosis, whereas the normal tissue cells of slower reproduction would not be so affected.

When radium needles are inserted into the tissues the prolongation of the total time of treatment can be accomplished by using needles of low intensity and subjecting the tissues to a continuous irradiation. With X-rays this is not practicable but the total dose can be given in individual fractions on successive days.

The treatment must, however, be designed as a single course in which the daily fractions of the total treatment have a cumulative effect. If these fractions are too small and the course of treatment is spread out over too long a period of time there will cease to be a cumulative effect on the cells of the neoplasm which will remain active and become

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small to be irradiated adequately by a field  $2\frac{1}{2}$  or 3 cm. in diameter. Although the diameter of the lesion may be small there may be considerable infiltration and the low voltage contact therapy tube may not have a sufficient percentage depth dose to ensure adequate dosage to the deepest part of such a tumour. In such cases an intrabuccal applicator can be used with the ordinary high voltage X-ray tube. Accuracy of beam direction can be ensured by having an aperture in the side of the applicator and using an electrical nasopharyngoscope as a periscope to see that the lesion is in the centre of the field.

It is not yet known what dose is required for each of the various types of tumour. It has not been widely confirmed that there is an appreciable difference in radio-sensitivity between the various groups of squamous carcinoma.

Success does not depend on the actual dose delivered to the neoplasm. The reactions of the normal tissues to that dose are of the greatest importance not only because of the possible development of oedema and necrosis but in the actual process of destruction and the disappearance of the neoplasm.

Radiotherapy for malignant disease in the mouth or throat causes severe local reactions which are painful, cause difficulty in swallowing, even of saliva, and depress the general condition. Radiotherapy is no easy alternative to surgery for the patient, but is an ordeal demanding the utmost co-operation and determination from him.

**Constance Wood: Technique of teleradium treatment.**—This form of therapy is called by various names—teleradium treatment, treatment by radium bomb, or by radium pack—its continental names are telecurietherapy and Radiumfernbestrahlung, while radium beam therapy is the term commonly used in Great Britain. Treatment by radium beam involves the use of radiation emitted by large quantities of radium of the order of 2 to 10 gm.

The technique and teleradium apparatus described here is that designed at the Radio-therapeutic Research Unit of the Medical Research Council.

The use of tungsten alloy in the construction of the 10 gm. teleradium apparatus instead of lead enables this unit (fig. 1) to be much better protected than earlier types of

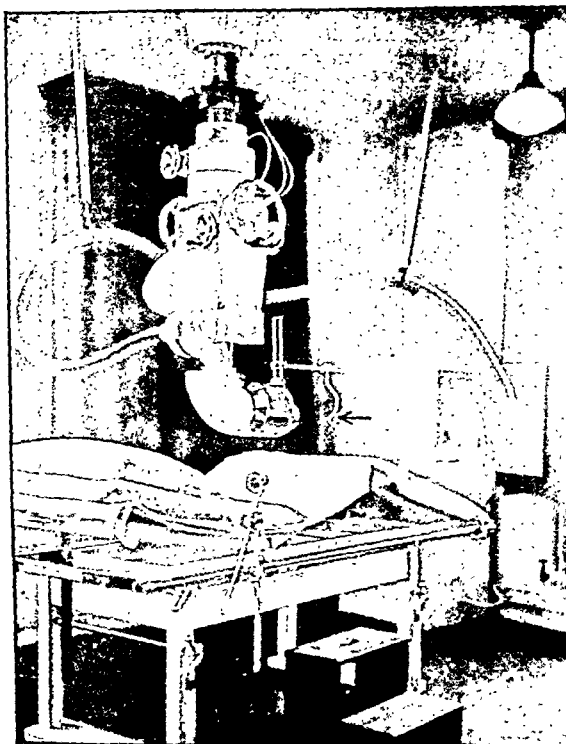


FIG. 1.—Ten grammes radium unit, with pneumatic transference of radium between unit and lead storage safe.  
MARCH—LARYNG. 2

immunized to the effects of radiation. There will, however, still be a cumulative effect on the normal cells, particularly those of the connective tissues. In fact, the technique will have become the inadequate one of multiple small doses and, therefore, the total period of treatment should not be in excess of thirty to thirty-five days in most cases. In many cases if an adequate total dose can be delivered in a shorter period, say ten to twenty days without causing undue local or general reaction in the patient, there are obvious economic advantages.

Experimental work has produced contradictory results. There is evidence that protraction of individual treatments causes less reaction in skin and subcutaneous tissues, thus allowing a greater dose to be given, but it has not yet been proven whether the destructive effect on the underlying tumour is not also less marked with protraction. Further clinical experimental work is being carried out both with the use of low and of very high dosage rates. It is obvious that many more patients can be treated on one X-ray tube in a working day with a dosage rate of 50 roentgens per minute than if it is limited to 5 roentgens per minute.

With the use of a single beam the dose in the tissues must be limited by the tolerance of the skin and to obtain adequate irradiation of any internal tumour when its radio-sensitivity is not much greater than that of the skin it is necessary to use more than one skin field, directing the beams so that they cross fire on the tumour and by their summative effect produce a dose at the tumour level which is as high as, or higher than, that received on each skin field.

A different quality of X-ray beam is indicated for the treatment of individual lesions, depending largely on their situation, whether superficial or deep in the tissues. There is no proof of any specific, selective, biological action dependent on wave-length but the effects observed are due to the amount of energy absorbed at any particular point. In superficial lesions which do not extend deeply into the tissues the aim is to deliver a heavy dose to the volume of the tumour in the first one or two centimetres' depth of tissue and to avoid injury to the subjacent normal structures. For this purpose X-rays generated at low voltage, i.e. 60 to 100 kV., are most appropriate and have a considerable field of usefulness. The contact therapy tubes designed for this purpose are especially convenient not only for superficial skin neoplasms but also for non-infiltrating primary growths of limited extent in accessible situations within the buccal cavity, such, for example, as the buccal surface of the cheek, floor of mouth, palate or anterior pillar of the fauces. X-rays generated at high voltages, i.e. 180 to 250 kV., are most appropriate for the great majority of malignant tumours treated in laryngological practice as they are situated at no great depth below the skin surface and a high tumour dose can be obtained by the use of multiple fields correctly planned and accurately directed. Super-voltage X-rays, i.e. those generated at kilovoltages in excess of 250, appear to be of no particular advantage in this field of practice except in such lesions as carcinoma of the œsophagus in its thoracic extent, where the lesion is at least 10 cm. from the skin surface and where it is more difficult to obtain an adequate tumour dose with multiple fields without irradiating the lung tissue to some extent.

In each case the first step is to plan the treatment in detail and with accuracy. The exact site, size and limits of extension of the primary lesion and of any metastases must be noted and related to surface markings. The choice of appropriate fields, their number, size, position and direction must be worked out in association with the physicist of the radiotherapeutic department. The aim should be to obtain a sufficiently large dose to the whole extent of the tumour together with the irradiation of a minimum of normal tissue, and to avoid damage to organs which are particularly sensitive to the effects of radiation. Fields should be chosen which give the shortest distance from the skin surface to the lesion. Care must be taken that the volume of the tumour is irradiated with a homogeneous dosage throughout its extent and that the region of maximum dosage in the whole volume irradiated is accurately centred on the tumour.

If the area is to be treated by one anterior and two lateral fields, these must be directed to a point slightly behind the larynx in order to obtain a homogeneous distribution of dosage on the larynx itself. If directed at the larynx itself the point of maximum dosage will be in front of the lesion and may precipitate necrosis of cartilage with underdosage to the tumour.

Some conditions need treatment by few large fields. Such are tumours which have widespread regional metastases or are likely to metastasize and are radiosensitive. Others, in which group are the majority of squamous-celled lesions, need multiple smaller fields in order to obtain a high tumour dose, whilst avoiding excessive damage to normal tissues. With small fields particularly, accurate beam direction is essential.

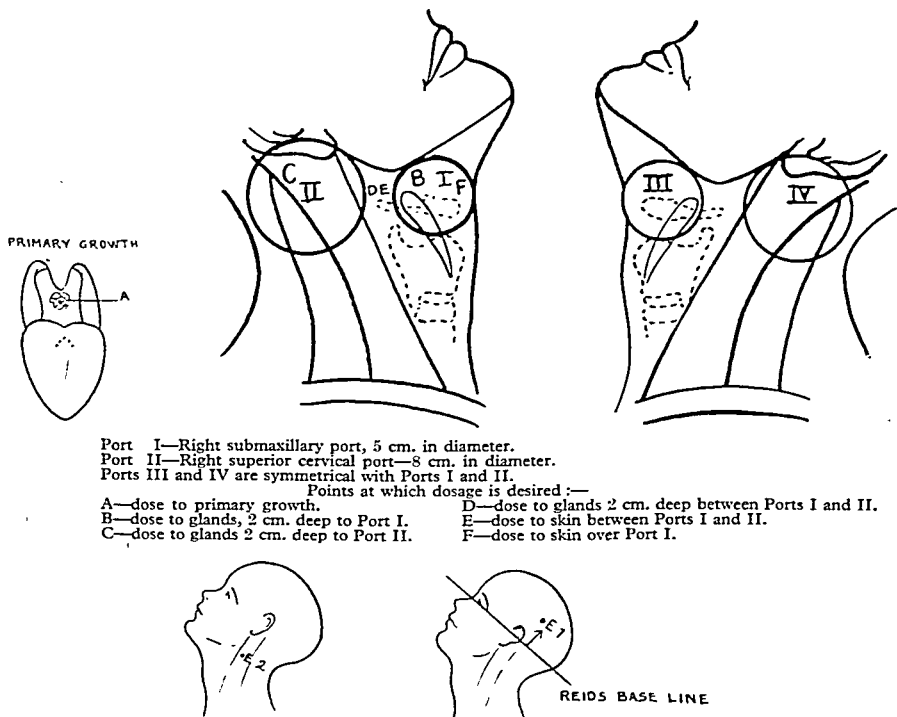
There is one method of beam direction which may not be mentioned by other speakers, but which has been found of value in the treatment of some lesions. Many primary lesions of the tongue, floor of mouth, palate, tonsil or pillars of the fauces are sufficiently

Since only a limited amount of radiation can be tolerated by the patient it is important for the success of the treatment that the total radiation be used to the best advantage. It is for this reason that in treating carcinoma of the oral cavity and pharynx, we irradiate the primary growth through its lymphatic drainage in the neck. In this way there is an economy in the total radiation delivered to the patient.

The details of the technique used may best be illustrated by a brief description of the actual treatment of one case.

The case illustrated is a growth on the posterior wall of the oropharynx. The four ports of entry through which it was decided to deliver treatment are shown in the diagram. The direction which the radiation is to take through each port is defined at E1 and E2. It will be noted that the direction has been so arranged that the radiation in all cases serves two purposes, radiating both primary growth and glands, and that no separate port for the primary growth only has been used. Thus, Port I, the Right Submaxillary Port, irradiates the submaxillary nodes, and then passes on to the primary growth to emerge in the left parietal region at E1. Port II, the Right Superior Cervical Port, irradiates the right superior deep cervical nodes, passes to the primary growth, and then on to the left superior deep cervical nodes before emerging at E2, the junction of the upper and middle thirds of the sternomastoid on the opposite side of the neck. The radiation so directed has thus served three purposes, radiating two gland stations, and the primary growth. Since the growth in the example given is centrally placed, there is a symmetrical arrangement of fields on either side of the neck, Ports I and II corresponding with Ports III and IV.

Certain key points are selected at which it is desired to know the dosage. By determining the dosage at these points for the particular combination of ports used, the strong and weak regions in the field of radiation are brought out, and hence the delivery of dosage can be accurately controlled. The points chosen in this example are indicated in fig. 2. A is the point on the primary growth; B, C, and D are the points in the gland area; and E and F are the skin points selected.



Emergent Rays: E 1—position of emergent ray for Port I. It is 5 cm. behind the external auditory meatus on Reid's base line and 7.5 cm. vertically upwards from this point. E 2.—position of emergent ray for Port II. It is at the junction of the upper and middle thirds of the sternomastoid.

FIG. 2.

[Reproduced from Brit. J. Radiol.]

teleradium apparatus and at the same time to be less bulky even though it contains much more radium, the largest quantity in fact used in any one unit in the world. The chief features in its design are that it affords increased protection to both patients and staff and also allows of much greater flexibility in treatment than was formerly possible.

The increased protection afforded when the alloy is used is important because when radiation received by the patient in all parts other than the cancer-bearing area is reduced to a minimum undesirable constitutional effects are avoided. Interchangeable applicators fitted at the treatment end of the unit enable areas of treatment of different sizes and shapes to be used and so permit of greater flexibility in treatment. The sizes of the applicators used in carcinoma of the mouth and throat are 5 cm. circle, 8 cm. circle, and 6 x 8 cm. rectangle. One of the most important advances in this unit is the perfection of pneumatic transference, first suggested by Sievert. The radium is blown by air pressure through a tube to and from the storage safe to the unit, thus no handling of the radium is necessary and all exposure of the staff is avoided.

In radiation treatment, especially with such small ports of entry as we use in the treatment of carcinoma of the mouth and throat, there is considerable difficulty in directing the beam of rays accurately at a tumour situated at some depth below the surface. When such small fields are used and the unit is set by eye, there is a possibility in some cases of missing the growth altogether. One of the causes of failure in radium treatment with small fields has been this inability to direct the beam accurately.

Various methods to obtain accurate aim were tried, and finally a caliper instrument as devised by Dr. Green was adopted. The instrument consists of a pointer arm which moves out along the central axis of the beam. The radium unit may be likened to a big gun: the beam of rays emerges from the mouth of the gun, the pointer of the caliper instrument is placed on the far side of the object to be struck and in line with it, and the scales mounted in relation to the pointer arm show the degree of accuracy of the shot and the direction in which correction must be applied. When using the instrument the small electric light bulb on the end of the pointer arm (indicated by arrow on fig. 1) is placed on the tumour within the mouth. The direction of the beam is then adjusted until the location scales read zero. The central ray is now passing through the centre of the tumour and the radiation field is uniformly distributed about it. The site of exit of the beam is in a direct line between the port of entry and the tumour. This site of exit, the emergent ray, is marked on the patient, and each successive treatment can now be repeated with precision. The error in directing the beam by eye is in this way eliminated. If the direction of the beam is to remain constant, it is essential that the patient does not move throughout the course of treatment. This is ensured by a simple stabilizing mechanism consisting of a number of padded clamps on universal joints, which maintains immobilization of the patient.

The three scales on the caliper instrument described above may be used to define the position of any desired point in the tissues. The position of this point can then be located on the dosage rate charts and hence the number of roentgens per hour at this point can be calculated. It is thus possible to measure the total dosage from all ports of entry for all planes.

An attempt is made to improve the general condition of all patients undergoing treatment. Adequate supply of nutriment is difficult in some cases owing to the reaction produced by treatment on the mucous membranes of the mouth and pharynx. In such cases the caloric intake is carefully controlled, and a high vitamin content given in the diet.

All septic teeth are removed before beginning treatment, and radiation is not started until the gums are healed. In some cases of carcinoma of the pharynx and larynx with cyanosis or stridor, a tracheotomy has been done before beginning treatment, but in less serious cases the beginning of the treatment has frequently alleviated the symptoms, and a tracheotomy has been avoided.

Where possible a radical radiation treatment is given, i.e. the regions treated are planned to cover the site of the growth, and its probable direction of spread. The limits of the primary growth and its lymphatic extensions must be determined as accurately as possible, in order that the whole of the diseased area may be irradiated. Soft tissue radiographs are often useful for outlining the lower limit of post-cricoid growths.

When choosing the ports of entry through which treatment is to be delivered, and deciding the direction the radiation is to take through each port, the object in view is to deliver to all parts of the cancer-bearing area an equal and adequate radiation. Unless the treatment is carefully planned, some areas will receive too little radiation and become the most likely place in which the disease will recur, while other regions in the centre or at the junctions of the fields of radiation are liable to suffer from over-dosage, with such unpleasant sequelæ as necrosis of cartilage and bone. Such results are commonly due to failures of technique.

appearance of these reactions varies but usually a slight yellow membrane appears on the primary growth about the end of the first week. This spreads and becomes a thick membrane about the fourth week and then slowly diminishes and disappears.

The reaction on the skin usually develops later than that on the mucous membrane. It frequently does not occur before the third or fourth week. It begins as a slight erythema, increases to a severe erythema and then the skin often becomes deeply pigmented and the epidermis is shed as a dry desquamation. In cases where the skin reaction is more severe, supervening on the erythema a few blebs appear. These coalesce and then finally the epidermis peels off leaving an area of moist desquamation. It has been found better not to cover this by any dressing, thus avoiding the trauma which would be caused in removing it. It has been treated either by acriflavine or 2% gentian violet which provides a dry crust under which the skin readily heals.

Paintings of growths in the hard palate, posterior third of tongue, soft palate, tonsil, pharynx and larynx were shown, illustrating the lesions, before and after treatment by radium beam. Figure 5 shows the isodose contours obtained by irradiating the

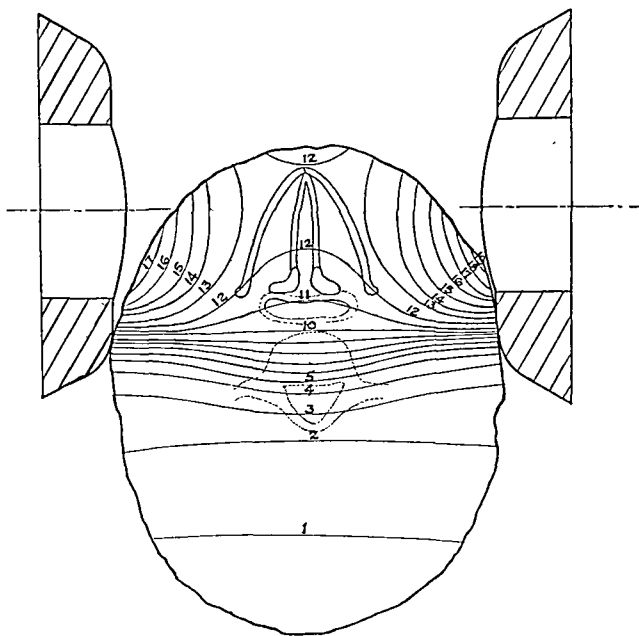


FIG. 5.—Isodose contours obtained by irradiating larynx with two opposing fields.

larynx with two opposing fields—an equalized dose is obtained throughout the whole of the laryngeal area. Diagrams of the ports of entry used and graphs depicting the dose delivered and the response to treatment in each case were also exhibited.

**Ralston Paterson :** *Radiotherapy in pharyngeal and laryngeal cancer.*—This paper deals with the technique of radiotherapy as applied to *pharyngeal and laryngeal growths*, with emphasis on radium.

There are two main types of malignant growth in pharyngeal and laryngeal cancer:

(1) *Squamous-celled carcinoma (or epithelioma).*—This can be found arising at any point on the mucous lining from post-nasal space to cricoid region.

(2) *Reticulo-endothelial growths.*—These are radiosensitive and are chiefly found in the post-nasal space, the tonsil and tonsillar bed, and the base of the tongue.

The distinction between carcinoma and the reticulo-endothelial growths is of vital importance as the principles of treatment are different. Where any doubt exists, and certainly in every case under 50 years, and in post-nasal and tonsillar growths, a biopsy before treatment is essential.

*Squamous-celled cancer* is the more numerous. Exact delimitation is of importance because the fundamental need of treatment is to irradiate the smallest possible volume which will yet enclose the whole tumour. The smaller the volume to be irradiated, the



Readings on the three scales of the caliper are then taken through every port of entry for each point at which it is desired to know the dosage. These are recorded as in Table I.

\*TABLE I.—CALIPER MEASUREMENTS FOR POINTS A, B, C, D, E, F.

Port No.	Scale	Caliper Measurements					
		Point A	Point B	Point C	Point D	Point E	Point F
I	V.S.	1.0	0.0	2.0	3.0	2.0	0.0
	H.S.	5.5	2.0	2.0	1.0	0.5	0.0
	C.S.	0.0	0.0	5.0	3.0	4.5	0.0
II	V.S.	1.0	0.5	5.0	3.0	3.0	1.0
	H.S.	5.5	2.5	8.5	6.5	6.5	2.5
	C.S.	0.0	3.5	5.0	5.0	7.0	6.0
III	V.S.	0.8	1.8	0.0	0.8	0.8	1.8
	H.S.	5.0	3.4	2.0	0.0	0.0	3.4
	C.S.	1.0	3.0	0.0	3.0	4.5	5.0
IV	V.S.	0.8	1.3	0.2	0.2	0.2	1.3
	H.S.	5.0	8.0	11.4	11.4	11.4	8.0
	C.S.	1.0	4.0	2.0	3.0	5.0	5.0

V.S. = Vertical Scale on Caliper.  
H.S. = Horizontal Scale on Caliper.  
C.S. = Circular Scale on Caliper.

The caliper readings are then referred by calculation to the dosage rate curves; in this way the dosage rate at each point is determined and recorded as in Table II. The dosage

\*TABLE II.—DOSAGE RATES AT POINTS A, B, C, D, E, F IN r PER HOUR.

Port No.	A	B	C	D	E	F
I	155	307	65	110	65	485
II	155	170	25	45	25	50
III	130	185	285	320	275	165
IV	130	85	60	60	60	75

\*Tables reproduced from *Brit. J. Radiol.*, 1937, 10, 89, by permission.

is controlled by varying the time of exposure through the different ports.

The daily progress of the dosage at each of the points is recorded and finally the dosage delivered is plotted on a graph (as illustrated in fig. 3) which shows the rising total in

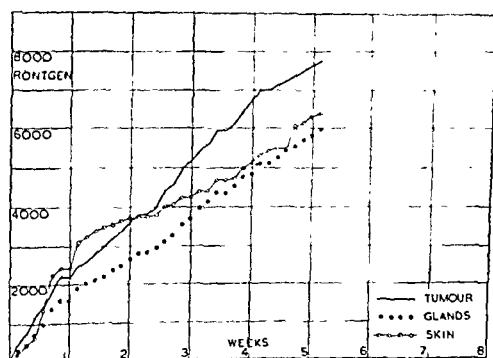


FIG. 3.—Dosage.

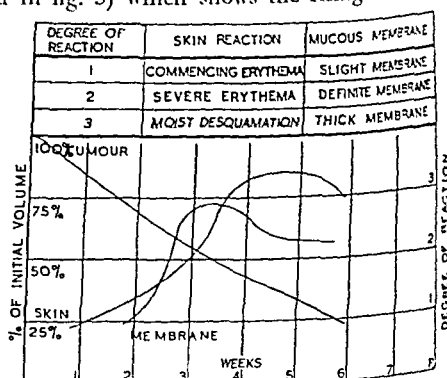


FIG. 4.—Reactions.

roentgens to the primary tumour, glands and skin on successive days of treatment. Varying dosage levels have been tried. It has been found that the best results were obtained when approximately 6,000 to 7,000 roentgens were delivered to the lesions in forty-two days. Two treatments of twenty minutes each are given daily. It was considered desirable to divide the treatment in this way because a short treatment time is less tiring for the patient and there is a greater chance of his remaining absolutely still.

The general response of each patient to treatment is recorded in the form of a graph which shows the response of the constituents of the blood, blood-pressure, pulse, and weight. An analysis of the blood-counts showed that treatment of the type described results in a fall in the total leucocytes due almost entirely to a diminution of the lymphocytes. There is a loss of weight in most patients during treatment and, as already mentioned, great attention has been given to the nutrition of the patient both during and after treatment.

The local reactions produced by the treatment are recorded in fig. 4.

The response of the tumour and glands to the treatment and the time of appearance of the mucous membrane and skin reactions are recorded in this way. The time of

and in the good cases the cure rate is high if they are treated radically in this way. The dose stated in roentgens is considerably less than with small field therapy but it is still radical, as the whole of a large volume of tissue is raised to the limits of tolerance. The reaction is marked both in the skin and in the mucosa. Swallowing may be painful for about two weeks at the height of the reaction, but the patients are often young, the cure rate is good, and radical therapy well worth doing.

There is no satisfactory radium alternative for these growths. Academically, the use of a large neck pack might be justified under exceptional circumstances. The need for wide field therapy is so great that a growth already partially treated under a wrong diagnosis by local radium, or by small field therapy, and found on histological examination to be of this type, should be transferred at once to the wide field plan. Spectacular response on the part of a supposed carcinoma of the post-nasal space or carcinoma of the tonsil, is a warning that diagnosis and treatment need reconsideration.

In conclusion, one general point requires special emphasis. When radical surgery is contemplated in the treatment of cancer in any part of the body, no one spares elaborate preparation and care. The availability of an expensive and properly staffed operating room is almost taken for granted. The operation itself may take hours. Radical radiation therapy aiming at cure ought nowadays to be an elaborate process with the same need for previous thought and preparation as a radical surgical operation. The X-ray exposure is merely one incident in the process. Much previous planning and charting is needed. Many cases require special applicators to be built, calling for a workshop known as a mould room.

N. S. Finzi suggested to Dr. Paterson that if he got late failures with the present method he was using by applying low-voltage X-ray therapy to the larynx, he should try a higher voltage X-ray therapy. It might still be a good method, only that the voltage might be too low. If there were recurrences after contact therapy he should try a high voltage with the same methods. There were technical difficulties with short distance high-voltage therapy which did not obtain with low-voltage, but they could be overcome.

He differed from Dr. Paterson in only one respect, namely, with regard to extrinsic laryngeal carcinoma, in which field he had had no prolonged success. He asked whether Dr. Wood had had any experience of intrinsic laryngeal tumours treated with teleradium. He was not sure whether the procedure could be carried out safely without fenestration. Coutard in his X-ray treatment of these cases had some cases of necrosis of cartilage. Sometimes these growths were very septic, and the necrosis was due to an infection which was probably never completely eradicated although the tumour itself disappeared.

There was one other method which he used in the treatment of laryngeal cases, namely, the relatively wide field treatment with its overlapping areas. This had been misused by others who had taken wider areas than he had ever done. He used overlapping areas and six angles with the idea of getting homogeneous irradiation.

Ffrangcon Roberts said that he agreed with what Dr. Paterson had said about extrinsic tumours. In those that he had treated, the glands were already involved when first seen and nothing could be done except palliative treatment. As regards intrinsic tumours, the case was very different, and nothing gave him greater gratification than to find that the small fields which he had introduced had been so widely adopted. But these fields of 5 cm.<sup>2</sup> or 3 cm.<sup>2</sup> he had now abandoned because they were too large and clumsy. His present method which he had used for six years depended upon the fact that no organ in the body had its position so closely defined or was subject to so little variation. He used seven 5 × 1 cm. fields with the long axis vertically going round the larynx, and to each of these fields he gave about 700 r (one field per day). The cycle was repeated in the following week, the total surface dose being from 10,000 to 15,000 r. It might be said that these fields, the disposition of which he showed in lantern slides, were unnecessarily long, but they had the advantage of covering the tumour below and above, and they did save the bother of localization in one plane. He had, however, since gone in for still smaller fields, and he showed an arrangement of seven 1.5 cm.<sup>2</sup> fields, and another with ten 1 cm.<sup>2</sup> fields in two rows of five. Thus each beam was almost limited to the tumour itself.

He first used 200 kV. with 1 mm. Cu filter, then changed to 200 kV. with 1 mm. Al and now used 120 kV. with 1 mm. Al. Although this last appeared to be a retrograde step it proved equally effective and had the merit of being much cheaper.

The great advantage of his method was the entire absence of any serious reaction of which so much had been heard. The three cases which he had treated five years ago were still free from recurrence.

J. Jackson Richmond described briefly the principles of a new method of teleradium treatment of intrinsic laryngeal cancer. He thought that it was in the treatment of malignant tumours of the larynx that teleradium had one of its chief applications. To

higher the dosage of radiation which can be given. The purpose of radical radiation treatment is to give as high a dosage as will be safely tolerated. It is a good general rule that the curability of a carcinomatous lesion is approximately inversely proportional to the size of the growth. Really small growths in this field are for the most part curable if proper treatment is instituted early and is radical. Indeed, the results of treatment in what is probably the smallest internal tumour diagnosed—namely, carcinoma of the vocal cord—are excellent, because the hoarseness is such an early key symptom. This growth is curable, not because of any special radiosensitivity, but because when first diagnosed it can be treated in ideally small volume and to a maximal high dose.

*Curative therapy.*—The mainstay of treatment is external radiation by X-ray or radium beam. This is in contrast to the treatment of mouth cancer. In mouth cancer accessibility makes intra-oral radium application technically easy and radium is nearly always preferable to any form of external radiation. Almost as if in illustration of the difference we find the faucial growth, in a sense, a neutral lesion in this respect—and X-rays and radium may be rated as of equal value.

Even in the pharynx and larynx, however, there are a few sites on which radium can be used as an alternative. The four good sites are these: (1) Finzi-Harmer fenestration implant for growths of the middle third of the vocal cord. (2) Sponge-rubber applicator for limited superficial growths in the post-nasal space. (3) Radon seed implant under direct vision in the oropharynx. (4) Radium-bearing collar combined with radium loaded bougie for limited growths of the hypopharynx.

With the four exceptions described, attempts at localized radium treatment of pharyngeal and laryngeal growths are better avoided.

Mention should be made of another technique for intrinsic cancer of the larynx which has been devised by Victor Lambert and T. A. Watson in Manchester. It is as yet a purely experimental piece of work. The whole ala of the thyroid cartilage is removed surgically, leaving only the inner layer of perichondrium. The larynx is given there and then a single high dose of radiation using a contact therapy plant. The wound is stitched up at once and healing is smooth. The method is too recent to report durability but the immediate results are satisfactory.

*Palliative therapy.*—Radiation is also of great value as a *palliative agent* alone. Radiation has a capacity for slowing up growth rate and causing partial or even temporary disappearance of a growth too large to allow permanent resolution. This results in a moderate prolongation of life and, really more important, great relief of symptoms. The dominant symptoms are dyspnoea, dysphagia, pain and occasionally haemorrhage. All of these can be greatly relieved. The mental relief from feeling so much improved is also real. When palliation is all that is possible a very different radiotherapeutic approach is called for. Radical treatment is not appropriate. Nevertheless to get any effect at all a considerable, though far short of maximal, dosage of radiation is still required and some reaction must still be taken. The course of treatment, however, can be profitably shortened and treatment given over a period of days rather than weeks.

*Reticulo-endothelial growths.*—The reticulo-endothelial growths are interesting because of their great radiosensitivity. The term reticulo-endothelial covers a group of growths whose common characteristic is that they are highly radiosensitive. The pathologists give them a variety of names—lymphosarcoma, reticulum-cell sarcoma, lympho-epithelioma, endothelioma, nasopharyngeal endothelioma, round-celled sarcoma.

In their response to radiation, these growths have two linked characteristics. They are both radiosensitive and radioresoluble. By *radiosensitive* is meant that they disappear or melt quickly under radiation. In the very sensitive the response is shown in the very first few days of treatment. A tumour which melts quickly does not *ipso facto* stay away. By *radioresoluble* it is indicated that with sufficient dosage, and yet such as can be given to big volumes of tissue, they not only respond at once but resolution remains complete in the treatment zone. With adequate treatment, local recurrence is very rare. They have, however, a third, a most tantalizing and unfortunate character, which deprives us of much of the advantage of their radioresolubility. They are highly malignant and have a tendency to rapid, wide and early metastasis. Localized treatment, such as has been outlined for the carcinomata, is usually futile. Big volumes of tissue have to be irradiated for what may seem limited growths. The radiologist has to think no longer in terms of 2 to 3 cm. clearance of all known growth, but of clearances of the order of 5 to 10 cm. in all directions from visible or palpable involvement. For post-nasal growths which grow through the foramina into the base of the brain fields must go upwards well into the cranial cavity. Downwards it is seldom wise to irradiate less than the whole length of the neck down to the clavicle, even in early cases. If there are already a string of nodes down the neck, or down both sides of the neck, the irradiated zone should go right down into the mediastinum.

High percentages of cure depend on getting the disease before general dissemination

## Section for the Study of Disease in Children

President—DONALD PATERSON, M.D.

[January 22, 1943]

### DISCUSSION ON THE PROPHYLAXIS OF THE ACUTE SPECIFIC FEVERS

Dr. E. H. R. Harries (*Summary*): In acute specific fevers the fundamental prophylactic measure is the provision and maintenance of a satisfactory environment which includes not only housing (with particular reference to bed spacing and ventilation), water supply and sewage disposal, but also adequate nutrition. To this must be added education of parents and teachers in the importance of hygiene and of early medical advice for the correction of hypovitaminosis, anaemia and dental sepsis. Good environment has the effect of postponing the age of attack of the common fevers. The poorer the environment the greater the incidence of measles among children of pre-school age and the higher the proportion of cases complicated by bronchopneumonia. During the 1940 to 1941 measles epidemic in London the ages of children admitted to the North Eastern Hospital were higher and the case-fatality rate (less than 1%) greatly reduced. From birth to elementary—or preparatory—school age the child's environment is that of its parents; later, for the greater part of the day, or of the year, as the case may be, it becomes the environment of the school which may be good, bad or indifferent from a prophylactic standpoint. The school provides the locus of infection; from thence it is conveyed to the child's home or dormitory. Early diagnosis of an acute specific fever may be impossible because the doctor is called late, or on a first visit the clinical phenomena may be too vague to justify more than suspicion. It should be allowable for the practitioner to request removal of a suspected case to hospital for confirmation without being obliged to make formal notification to the medical officer of health. Late isolation is for prophylactic purposes a bed wasted and frequently provokes an aftermath of secondary cases in the family or school. The modern fever hospital, like any other hospital, cannot function efficiently either in diagnosis or control without first-class laboratory assistance. Although isolation in hospital has failed as a communal measure of control, yet it is of importance in the case of the individual family or institution since it secures the removal of an abundant reservoir of infection and so limits the number of contacts. During recent years considerable modifications have been made in the length of isolation. The period has been reduced in scarlet fever by the use of antitoxin which is advantageous even in clinically mild cases. Concurrent disinfection is of much more importance than terminal disinfection, for which ordinary spring-cleaning and the open window sufficed.

As for contacts, with the aid of the Schick test in diphtheria and the Dick test in scarlet fever and the appropriate platings on blood agar and tellurite media respectively, it is possible to divide a school community into the safe and the unsafe; the latter are either susceptible and in danger themselves or immune carriers and therefore dangerous to others. The dangerous carriers must be segregated and treated as such; the safe individuals can be released; the unsafe should be immunized. In the protection of susceptible diphtheria contacts it is desirable to combine passive and active immunization, thus providing immediate temporary protection followed by solid active immunity. The duration of passive immunity produced by scarlet fever antitoxin rarely exceeds ten to fourteen days. Active immunization against scarlet fever by multiple skin test doses of toxin is a lengthy and cumbersome process and the duration of active immunity is

obtain homogeneity of dosage precise alignment of the fields was required. In this region the angulation required would be highly critical; any relatively small deviation from the directions of the axis beams would cause gross disturbance to the dosage uniformity with consequent risk of excessive irradiation of the laryngeal cartilages. Consequently it would be preferable to have some arrangement whereby a volume which was relatively uniformly irradiated could be set up, and the patient, or rather the lesion, placed inside this zone. Working in collaboration with Dr. Wilson of the Department of Physics of Westminster Hospital, he had designed a cervical frame which could be accurately applied to the appropriate surface landmarks of the neck to give the required conditions of irradiation.

Professor Windeyer had shown the dose contours obtained from the employment of three 3.5 cm. circular fields with the 4 Gram radium unit. The most striking fact was that the optimum dosage distribution resulted when the axis beams of the two lateral oblique fields were directed posterior to the lesion. Consequently the frame-work was so made that the radium bomb head was held in a pre-determined position, and as the actual zone of irradiation set up must be always constant it was unnecessary to employ the more elaborate methods of beam direction, excellent as they were.

With this technique it was only necessary to adjust the frame to the patient's neck accurately and the lesion would automatically fall into the focus of uniform irradiation.

D. W. Smithers mentioned the value of a series of tomographs as a means of localizing the size, shape and position of tumours.

V. Lambert showed a colour film illustrating the technique of the surgical exposure for contact X-ray treatment of the larynx. This was referred to in Dr. Paterson's paper. The film was made by Mr. James Weeks, late of the American Ambulance Unit in Great Britain. Mr. Lambert said that the surgical exposure shown so briefly on the film took anything from twenty-five to thirty-five minutes. The tube was then placed in position by his radiological colleague, and the irradiation occupied about another half-hour. The procedure had been carried out in 16 cases. There had been no operative mortality. One death had occurred from recurrence and one case showed doubtful recurrence (more probably necrosis); also one death from an intercurrent disease, though the larynx itself was healed. Nothing was claimed for this treatment at the moment, because there had not been enough cases, but if it was successful it was safe to predict that an attempt would be made to utilize it for cases in which both sides of the larynx were involved.

B. W. Windeyer, in reply, said that the classification of squamous carcinoma had so far given very little help in questions of dosage. They were constantly finding cases where very undifferentiated growths seemed to be more resistant than others which were well differentiated. He was aware that statements had been made quite frequently in the past that well-differentiated growths should not be treated by radiotherapy because they were going to be unresponsive. He did not think that was true. There were possibly among the cases which had been cured quite a large proportion which had had well-differentiated growths.

He thought that it was not yet possible to make an authoritative statement as to whether telerradium in any situation was preferable to X-rays. At his hospital they had been working with telerradium alongside X-rays since 1932. His opinion so far, though not as yet backed by statistics, was that there was no definite advantage. What could be obtained by telerradium could be obtained, given the proper technique, by X-rays. He supported Dr. Smithers as to the value of tomography in finding the exact size and limits of laryngeal and pharyngeal growths.

Constance Wood, in reply, said that Dr. Finzi had spoken about necrosis as a possibility after the treatment of intrinsic laryngeal tumours with telerradium. She thought that with carefully planned fields it was possible to avoid this sequel.

As to the relative value of telerradium and X-ray therapy in treatment of carcinoma of the mouth and throat an investigation was at present being carried out at the Radiotherapeutic Research Unit in which a series of cases were being treated by X-rays using exactly the same technique as had been used in treatment by radium beam. The results would provide a basis for an unbiased comparison of the relative merits of the two methods.

Ralston Paterson, in reply, said that in the technique which Mr. Lambert had described the radio-therapeutic exposure took about half an hour. Both deep X-ray and contact therapy could be used in treating the larynx in this way but, for the present, results of contact therapy only were being reported. The treatment was in its experimental stages, but out of 11 cases, 8 were obviously well, though whether the cures would be durable or not only time would prove. The question of assessing beam therapy against deep X-ray therapy was one in which it was very difficult to arrive at any method of assessment. The main thing was to get an adequate dose of radiation to the whole involved area and any method by which that was achieved was the right way. There was an academic argument in favour of bomb therapy but, if X-rays were as effective, then on economic grounds that method had advantages.

**Quarantine.**—In the past quarantine of contacts and isolation of patients were accepted prophylactic measures. My predecessor, Dr. A. I. Simey, was shocked by the waste of school time consequent on the strict imposition of quarantine when exposure to infection was suspected, and framed our medical regulations so that a boy who had been exposed to certain infectious diseases could return to school provided he was isolated from the source of infection as soon as it was recognized. To-day we observe no quarantine for measles, rubella, mumps, whooping cough, chickenpox, scarlet fever, diphtheria; and this policy has been amply repaid. Table II shows that of 128 exposed, from 1933-1939, 60 had not had the disease, and these would have had to be quarantined for a total of 1,336 days, and if all exposed had been quarantined as is the practice in some schools, nearly double the time would have been lost. Of these 128, two developed the disease—one developed whooping cough in the summer holidays, and one got mumps at school, but was isolated at once and caused no further cases.

Infections are introduced unwittingly into schools. From 1931-1942 at Rugby there have been eight outbreaks of measles, eight of mumps, ten of rubella, two of whooping cough, fourteen of chickenpox, twelve of scarlet fever, and one of diphtheria, and not one of the originators knew he had been in contact except the one case of mumps already mentioned. This completely vindicates our present regulations.

**Diphtheria immunization.**—It seems to be extraordinary that a large percentage of a population like a public school can suffer from measles, whooping cough and chickenpox and yet escape from diphtheria. Table III shows the results of testing nearly 600 boys for immunity against diphtheria. Those who were positive were immunized with three injections of 1 c.c. of formol-toxoid given at fortnightly intervals. Table IV shows the

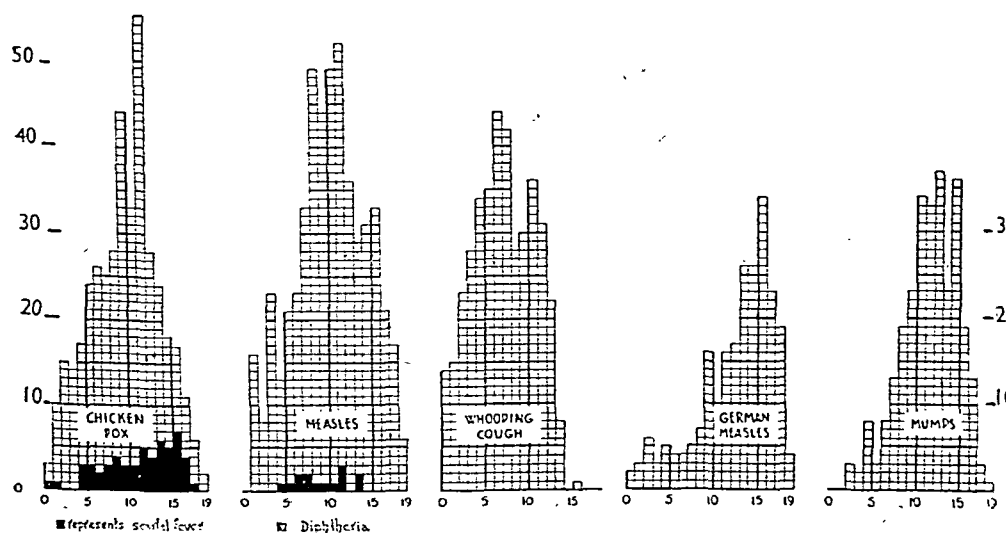


Chart I.—The uprights represent the number attacked in any particular year; the horizontals the age of the boy from 0 to 19 (Rugby School 1931-35). Reprinted from *The Practitioner*, 1935, 135, 233, by permission.

results of retesting after various intervals. These who were immunized have maintained their immunity although during that time there has not been a single case of diphtheria at Rugby. London is reputed to have a high rate of diphtheria carriers, at one time said to be 7%. It is important to realize that healthy boys may retain the immunity conferred on them by the usually practised method of immunization.

The benefits of positive health in resisting the aural and respiratory complications of measles and scarlet fever cannot be over-emphasized. Measles is not a disease characterized by catarrh in well-nourished boys. Routine temperature-taking of those exposed to measles helps to detect the early case.

uncertain. With the prevailing mild type of the disease and the availability of antitoxin and the sulphonamides, the process, except in the case of those specially exposed, such as nurses, seems scarcely worth while as a routine.

Active immunization against measles by nasal instillation of the virus is still in an experimental stage; results upon a small scale appear to be promising. Total passive immunization (sero-prevention) or partial immunization (sero-attenuation) are established practices; the antibodies injected are contained in convalescent serum, adult immune serum, placental extracts or parental whole blood. For familial contacts parental whole blood is to be recommended for attenuation. Its disadvantage lies in the large dose required. The routine prophylactic use of the sulphonamides for the prevention of concomitant streptococcal or pneumococcal infections in measles is to be deprecated (agranulocytosis and drug-fastness). Convalescent serum has been employed for the prophylaxis of chickenpox and mumps with equivocal or disappointing results; the practice is not worth while. Whooping cough in infants is so serious an affair that Maclean's advice to inject convalescent serum and to cover the cot with muslin to protect the infant from familial cases should be adopted.

**Dr. A. W. Downie:** *Prophylaxis of pertussis.*—The incidence of pertussis is highest in the age-group 3-7 years, but the mortality is greatest in the first year of life. Available data in this country and America showed that nearly half the deaths occur among infants under 1 year.

Vaccines have been tried, particularly in America, for the prevention of pertussis. While a few of the earlier results were not very satisfactory, recent reports of field trials have been distinctly encouraging. The trials recorded have not all been equally well planned and strictly comparable control groups of uninoculated children have not always been kept under observation. The practice in America has generally been to inject 80,000 million organisms in three or four injections at intervals of a week or more between injections. Further carefully controlled observations on the effect of smaller dosage and perhaps vaccines prepared in different ways from virulent strains of *H. pertussis* are desirable.

Adult human serum or whole blood, convalescent serum or hyperimmune human serum have been tried both in treatment and in prophylaxis. The treatment of the established disease has not been very successful but serum has apparently been more promising in preventing the disease in contacts.

As pertussis is such a serious risk during the early years of life the very young should be kept isolated from cases. Inoculation of infants under six months of age with pertussis vaccine might be considered as a specific prophylactic measure. When babies have been exposed to cases in the infectious stage, the injection of convalescent serum would appear to be sound practice.

**Dr. R. E. Smith (Rugby):** To assess the value of the prophylactic measures taken against the acute specific fevers in an institution, such as a residential school, one must study the natural history of infectious diseases. Table I and Chart I show the usual risks the average public schoolboy is likely to run from birth up to the school-leaving age of 18 years. Parents who fill up the questionnaire from which this information is obtained invariably give reliable evidence. Several simple facts stand out: that nearly everybody will have had measles, chickenpox and whooping cough before leaving school and will have gained permanent immunity; that scarlet fever is troublesome; and that diphtheria is exceptional. Chart I shows that whooping cough has a high attack rate in the first two years of life. The incidence of 14 cases of whooping cough in the first year is in striking contrast with the complete absence of measles. If we were able to include in these figures those who died, we would realize the great importance of infection in the first year of life. The death-rate of whooping cough is greater than that of diphtheria and scarlet fever combined, and measles in the first two years of life has a fatality rate of over 8%. The figures are significant even for those living under sheltered conditions, and it is probable that even more ominous facts would be found about the town dweller. Therefore every child in the nursery should be actively immunized for whooping cough and he should also be given passive immunization against measles.

## Section of Medicine

President—GEOFFREY MARSHALL, O.B.E., M.D.

[January 26, 1943]

### DISCUSSION ON THE EFFECT OF WARTIME CONDITIONS ON THE HEALTH OF THE FACTORY WORKER

Dr. J. M. Davidson : To assess critically the effect of wartime conditions on the health of the factory worker, we must first have a clear conception of the term factory worker to-day. There are first of all the old hands—the skilled and unskilled workers, male and female, of peacetime. These have been much diluted by new labour. There is the female worker with only a distant background, if any, of industrial experience; the agricultural worker turned factory hand; the deskworker who has been directed to the bench; the previously unemployed, and perhaps unemployable; and even the hobo who has been rounded up off the roads. Some of those who, prior to the war, led a comparatively sheltered, and in some cases, relatively idle life, are to-day working hard under unfavourable conditions. Others now gainfully employed in modern well-appointed factories were previously unemployed and poorly nourished. Conditions vary widely in different trades and in different factories. It must be remembered too that there is now virtually no free choice of work. In peacetime natural selectivity ensured to a large extent that a man or woman gravitated towards the job for which he or she was most suited. Women were employed in the main on light assembly jobs, while hot and strenuous labour was regarded as the province of the more husky type of male. To-day women work side by side with men in hot foundries and moulding bays.

The principal changes effected in the life of the factory worker by wartime conditions may be listed briefly as the concentration of less-essential industries and the consequent transfer of labour from these, resulting dilution of labour elsewhere, increased hours of work and the addition of civil defence duties, changes in environmental conditions, and the more personal factors of domestic upheaval, altered nutrition, and additional mental strain and worry.

*Concentration of less essential industries and the transfer of labour.*—The results of concentration have been the transference of some workpeople to factories in which they can carry on their previous occupation, and of others to factories perhaps far removed from their homes, in which they have to start an entirely new, and, it may be, distasteful job. In some cases this has involved a distinct improvement in working conditions since the factories left open are, in the main, the more modern ones, capable of rapid expansion of output. This has been the case for example in the potteries, where workpeople from small, ill-managed and ill-kept factories have been transferred either to larger, more modern and better-managed concerns or to munition factories. For those left in this trade, a further advantage has been that workpeople previously continuously exposed to the health risks inherent in the use of raw lead glazes, and in the use of free silica in the form of flint for china bedding, are now no longer at risk, since they work in their new surroundings with leadless glazes and use alumina for bedding in place of flint. I know of only one case where the reverse has taken place, and workpeople previously employed by a small but progressive firm have had to revert to the use of flint after working for years with alumina. On the whole, therefore, the concentration of non-essential industries has resulted, for those left, in improved working conditions. It is unfortunately not always so for those compulsorily removed to essential war work. Here workers from "safe" industries may be exposed for the first time to toxic substances such as T.N.T., and while every care is taken to ensure that only reasonably fit persons are so employed, the exigencies of war demand that the partly fit be found employment also, and it is not always possible to "place" such workers in appropriate jobs.

The compulsorily transferred worker presents us with two new and difficult problems—transport and billeting. Firstly there is the question of travelling to and from a more distant job. An unduly early start from home, often with little or no breakfast, a long walk to a conveyance and then, in many cases, prolonged standing in a crowded vehicle,



TABLE I.

Total investigated ... 513 leaving Rugby School 1931-35.

			Number attacked			Number not attacked
			1 attack	2 attacks	3 attacks	
Chickenpox ...	...	...	423	5	—	90
Measles ...	...	...	493	6	—	20
Mumps ...	...	...	245	2	—	265
Whooping cough ...	...	...	382	1	—	131
German measles ...	...	...	238	17	1	277
Diphtheria ...	...	...	14	—	—	499
Scarlet fever... ..	...	...	55	—	—	458

TABLE II.

Disease with which boy was in contact	Mumps	Measles	Rubella	Whooping cough	Chicken-pox	Scarlet fever	Total
	33	30	18	12	15	20	123
Number with history of previous attack or negative to intra-dermal test for S.F. ...	9	24	7	9	9	10*	68
Number with history of no previous attack ...	24	6	11	3	6	10	60
Length in days of usually advised quarantine ...	30	16	21	21	21	10	
Days lost if all are excluded ...	990	480	378	252	315	200	2,615
Days lost if only those are excluded who have not had clinical attack or are not negative reactors to intra-dermal tests ...	720	96	231	63	126	100	1,336

\* 8 known to be Dick-negative; 2 others have been actively immunized.

TABLE III.

Designation of House	A	B	C	D	E	F	G	H	I	J	K	Total
Number in House	57	57	53	58	56	54	58	55	57	60		595
Number already found to be immune ...	1	1	2	—	—	—	2	1	2	—		9
Number already immunized ...	2	—	2	5	2	2	2	2	1	2		20
Number wishing no action to be taken ...	1	2	1	1	1	2	2	2	—	3		15
Number with history of clinical diphtheria ...	—	3	2	1	—	2	2	1	2	1		14
Number Schick-positive...	70	45	37	42	45	34	38	41	47	44		443
Number Schick-negative	13	6	9	9	8	14	12	8	5	10		94
Percentage Schick-positive	84	88	80	82	85	71	76	84	90	87		82

TABLE IV.

Age last birthday	13	14	15	16	17	18	Total
Number tested...	54	130	124	100	97	32	537
Schick-positive...	49	117	107	70	75	25	443
Schick-negative	5	13	17	30	22	7	94
Percentage Schick-positive	91	90	86	70	77	78	82

metal (a magnesium-base alloy), for example, fires readily in a molten state, and it is customary therefore to keep dusting exposed surfaces with flowers of sulphur to maintain a reducing atmosphere of sulphur dioxide. This results in constant vitiation of the atmosphere in shops which at best may be poorly ventilated. In the case of copper alloys again cadmium, phosphorus, and other toxic elements may be incorporated at temperatures which render the evolution of dangerous fumes inevitable.

I have referred already to the complete environmental changes which may affect the transferred worker, the man or woman who, coming from a safe job, is thrust without special training into a job involving a specific health risk. It is difficult at any time to assess fitness for exposure to toxic substances, and particularly so in the case of liver poisons such as T.N.T. and the fumes of the chlorinated naphthalenes. Tests of liver function, even if reliable, are impracticable when hundreds of persons of both sexes and all ages are hurriedly gathered together and transferred to war factories. In the case of some other specific occupational hazards the difficulty is even greater, since susceptibility cannot be assessed at all by clinical means. Benzol poisoning and the effects of exposure to radioactive materials are in this category. In such cases the severity of the risk is dependent partly on the individual's personal habits and cannot wholly be met by control of harmful dusts, fumes and gases. Where neither the employer nor the employed has had previous experience of the toxic agent, mistakes are bound to occur and may not be discovered until overt illness has supervened. Prior to the war, as a result of assiduous propaganda and restrictive legislation, benzol had been largely replaced as a solvent by toluol and other less toxic homologues. Now, as in the last war, it has come into its own again while toluol is reserved for other purposes, and we are finding cases of dys-hæmopoietic anæmia due to excessive exposure. Similarly, radioactive materials are now used in industry on a wider scale than ever before.

Recently a colleague and myself investigated a series of three curious cases of dys-hæmopoietic anæmia. These three were all girls in their early twenties, unrelated to each other; all were sent, within a short space of time, from the same small Yorkshire town to two factories in Birmingham: all developed dys-hæmopoietic anæmias. Two of the girls probably made use of mixed solvents with a low benzol content for hand-cleaning—they developed respectively an aleukæmic myeloid leukæmia (fatal) and a severe secondary anæmia with relative lymphocytosis: the third girl, with no known contact with any toxic agent, developed a fatal acute lymphatic leukæmia. What is the connexion between these three cases? Is there a common factor, occupational or other? I don't know, but that is the sort of problem we have to tackle in industry to-day.

*Personal factors—nutrition, domestic upheavals, worry.*—*Nutrition.*—The physical health of the industrial worker has been maintained at a fairly satisfactory level, largely, I believe, because of the steps taken to provide in the factories canteens in which satisfying meals can be purchased at low prices. During the earlier part of the war the industrial worker had thrust upon him, haphazard, large quantities of expensive vitamin concentrates. Gradually, saner counsels prevailed and much of the money previously spent on vitamins is now deflected towards the subsidizing of canteens. Works' Medical Officers are beginning to remember that vitamins do not obviate the need for calories. Unfortunately, a large number of workpeople do not, for a variety of reasons, take full advantage of the canteen facilities available, and try to make do with what they can bring from home or billets. In some cases, the proportion of workpeople making use of a factory canteen is as low as 10%. I have mentioned the case of the young girl in billets, and that of the manual labourer in the hot and strenuous trades, but there are others also in which, in my opinion, recognizable malnutrition can be attributed to a shortage of first-class protein and an ill-balanced diet generally. Such a case is that of the ex-farm labourer who previously lived well if simply, on natural foods, and who now depends on rationed town fare.

*Domestic upheaval, worry.*—The factory worker, because of his varying shifts, is even more dependent than others for his general well-being on his wife and his home. When he is away from both, or when his wife is also employed, he is rather lost, and tends to pay insufficient attention to his health. The better type of worker too, the skilled man, suffers most in this respect. The free dilution of labour in the larger factories has resulted in the skilled worker of pre-war days being given a more responsible and more arduous job. Despite the continual upgrading of new entrants to industry the success or otherwise of the large munition factory is still largely in the hands of the junior managerial grades, the plant engineer, and the skilled tool-setter. These are the men, for the most part steady, reliable and conscientious, who have had to take the strain, and who, more than others, are showing now its ill-effects. Responsibility for widely-scattered dispersal units increases their cares. These men know no set hours. They

are poor preparations for an arduous day's work or for exposure to toxic substances. Travelling facilities have improved of late, and in many cases the tedium of the daily journey is relieved by the more friendly atmosphere of the "private" bus, but long-distance travelling still adds a great deal to an already long working day. To illustrate what happened in the earlier stages of the war, during the hurried staffing of new factories, I may quote a personal experience. Noticing a girl of 19 yawning mightily one afternoon, I inquired about her habits and learnt that she got up at 3.30 a.m., walked a few miles to a station, dozed through a railway journey, and was conveyed from the station by bus, still half asleep, to the factory. That poor girl was absent from her home in the country for over eighteen hours per day.

*Billeting.*—I associate the problem of billeting particularly with the young female transferee. Uprooted from the conditions of life to which she has been accustomed, and thrust into billets, her lot is often a hard one. Working previously for a modest wage at some small factory or shop near her home, perhaps in a rural or semi-rural area, she has been in the habit of turning over most of her earnings to her parents, and, in return, of living at home and receiving all their care. Such a girl all too often is not a good mixer; she has little idea of true values, no experience of judicious budgeting and next to no knowledge of the principles of nutrition. She attempts to send home money which she can ill-afford, and if she is of the quiet, introspective sort she is rather bewildered by the bustle of the large, soulless factory and suffers in consequence from acute homesickness. The tougher type of young female, on the other hand, reacts to the demoralizing influences of war in a different manner, tending to spend her larger wages in fripperies of all sorts and her leisure in taverns and picture palaces.

*Increased hours of work and the addition of civil defence duties.*—Broadly speaking, the problem here, as I see it, is the adult male. The Factories Act, and wartime legislation enacted under the Defence Regulations, regulated the hours of employment of the protected classes—women and young persons—but apart from agreements between employers and Trade Unions, &c., there is, in general, nothing to limit the hours which may be worked by men. The firm stand made by the Government in an effort to retain rational hours of employment and decent working conditions in the days of panic after Dunkirk had to give way in the long run to a certain elasticity, but the price of a struggle is seldom so high as the price of capitulation, and to-day the permissible hours of work for the protected classes are on the whole, not unreasonable. Unfortunately, as I have indicated, the position is sometimes otherwise in the case of men. There are still some factories, and indeed whole trades, in which men have been putting forth their maximum effort over a long period with insufficient rest, little leisure, and, in some cases, inadequate nourishment. I refer particularly to hot and strenuous work such as one finds in the steel trade and in metal foundries. Such men, in happier days, constituted almost wholly a picked class who worked less hard under better conditions and who at the same time were more adequately fed. In the main they were big meat-eaters. To-day they do without the very full meals they were accustomed to, travel long distances to work, work longer hours under less good conditions, e.g. of ventilation, and spend a large part of their scanty leisure time in Civil Defence duties. The French have a proverb "he who sleeps has dined", but when a man has neither slept nor dined adequately, he must inevitably begin to suffer sooner or later from progressive fatigue. But gross signs of fatigue may not appear for some little time, and many production experts still fail to realize that even the meretricious advantages which may sometimes be gained by overdriving cannot possibly accrue to the firm which has to depend on a tired personnel.

*Changes in environmental conditions.*—In a great many factories a hurried and effective blackout was achieved in the first instance merely by closing all openings to the exterior, and black-painting roof-lights and windows. This of necessity, permanently excluded natural lighting during the day, and interfered seriously with natural ventilation at night. In some cases it interfered also with existing mechanical ventilation, since fan openings to the exterior were sometimes boarded up or, at best, restricted by the erection of light traps. In some factories such as glass houses and foundries, this meant a harmful accumulation of fumes, toxic and other, and, in addition, failure to dissipate excess heat. I have personally seen many cases of metal fume fever, metallic poisoning, heat exhaustion and undue fatigue which would never have occurred had ventilation been adequate. Fortunately much has been done since to ameliorate these unsatisfactory conditions, but in many foundries and forges conditions are still unsatisfactory. In such factories the pressure of work is higher to-day than it has ever been before, so that metal pouring, for example, may be carried out in an ill-ventilated corner of a foundry where previously it was restricted to a specially ventilated bay. This applies particularly to the light alloys of aluminium and magnesium for which there is such an enormous demand. Elektron

metal (a magnesium-base alloy), for example, fires readily in a molten state, and it is customary therefore to keep dusting exposed surfaces with flowers of sulphur to maintain a reducing atmosphere of sulphur dioxide. This results in constant vitiation of the atmosphere in shops which at best may be poorly ventilated. In the case of copper alloys again cadmium, phosphorus, and other toxic elements may be incorporated at temperatures which render the evolution of dangerous fumes inevitable.

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work early and late, and even seize brief holiday-periods for essential maintenance work or for planning.

**Conclusion.**—On the whole, the health of the industrial worker of to-day is good. A satisfactory general level has been attained by lowering the standard of the previously prosperous, the "thrivers", in order to raise that of the "strivers" whose employment and therefore nutrition was more precarious in pre-war days. A slight fall in standards of nutrition may perhaps be deduced from the increase in the general incidence of tuberculosis and from an increased tendency towards sepsis following minor accidents (although the loss of time due to sepsis is less) but generally speaking, factory life as such has little specific adverse effect on health. In the larger well-equipped and well-organized factories, hygienic conditions are good; in some smaller concerns and in rapidly expanding factories housed in unsuitable premises, special risks arise, but these are all the time being systematically tackled.

**Dr. Horace Joules:** The hospital which I attend as in-patient and out-patient physician has approximately 1,000 beds, is surrounded by numerous factories employing 200 to 500 people, with a few larger factories interspersed. The main industries are associated with the making of aircraft and light engineering works generally. We do not see much of the toxic hazards of industry.

The main factors associated with wartime conditions which appear to affect adversely the health of patients seen may be listed as follows, in their order of importance.

(1) Excessive hours of work for too long a period. (2) Inadequate holidays. (3) Inadequate meals; especially among married women with domestic responsibilities. (4) Inadequate travelling facilities. (5) Inadequate lighting and ventilation within the factories. (6) Home Guard and fire-watching duties superimposed upon long hours of factory work.

The condition in the general out-patient department resembles the conditions obtaining in the surgeries of the neighbouring practitioners who assure me that there has been a great increase in the number of patients who are attending their surgeries. This increase has been very noticeable in the past fifteen months and still continues. Many of the patients attend for what they can only describe as nervous debility, and what might be more accurately described as either an anxiety state or exhaustion phenomenon.

The chief symptoms are: (1) Loss of weight, which may be extremely marked. (2) Increased nervousness and irritability. (3) Pallor. (4) Coarse tremor.

These conditions are being particularly noted among the more highly skilled workers and those holding fairly responsible positions as inspectors. Careful examination fails to reveal any organic abnormality. This type of case constitutes about 30 to 40% of the out-patients who are now referred to the medical side of this hospital. The following are typical illustrative examples:

M. C., aged 37. Female. Married with three children. Works as an assembler in artificial light for 11½ hours daily on four days, and for 9 hours on the fifth day. She gets up at 5.30 a.m., cooks a midday meal for her children and then gets their breakfast. She reaches work at 7.30 a.m. She returns home at midday, reheats the meal for the children and returns to work at 1 p.m. She returns home at 7.30 p.m., when she gets her husband's meal, does the housework, and usually retires to bed at 12.30 a.m. Her husband leaves home at 6.20 a.m. and returns either at 6.40 or 7.40 p.m. on alternate weeks. He has a gastric ulcer. The patient complained of severe headaches, increasing depression, general lassitude and loss of weight. There were no organic physical signs beyond some degree of microcytic anaemia, with hæmoglobin of 69%. Six weeks at a convalescent home restored her to normality, but she does not feel able to resume factory work.

B. P., aged 50. Female. Married. Works as an inspector for 12½ hours daily for five days and 10 hours daily for one day. Previously she had been working for 10 hours each Sunday. She complained of extreme nervousness and tremor; she had claustrophobia and phthisiophobia and was the prey of many other fears. On careful examination there was no evidence of organic disease and, again, one month's convalescence was necessary before she was capable of resuming a much restricted factory life.

T. D., aged 28. Male. Married. Works as a fitter in an aircraft factory. Since the outbreak of war until August 1942 he had been working 12 hours daily for seven days a week, with one week's holiday in two years. Since August he has worked 63 hours weekly. He complained of loss of 3 st. in weight, marked lassitude, precordial pain and he had phthisiophobia. Complete examination, X-ray of the chest and electrocardiogram were quite normal. Once again prolonged convalescence was needed.

I encourage these out-patients to talk for at least ten minutes, at the outset of the consultation, about their work and the chief wartime factors associated with it. It is in this way only that one can begin to form a reasonable opinion of the background which has played such an important part in the causation of their symptoms.

In the hospital wards more serious conditions are found which are closely related to the factors under consideration.

*Pneumonia.*—Since July 1942 I have treated 68 cases of primary pneumonia in adults, and of these 85% have been in people engaged in factory work. It is difficult to dogmatize on the relationship between factory conditions and the onset of pneumonia; but a few typical case-histories strongly suggest there is a close relationship.

J. B., aged 53. Male. Aircraft labourer. Works 70 and 83 hours weekly on alternate weeks and spends one hour a day travelling. He does 12 hours a week fire-watching. Admitted with typical lobar pneumonia, involving the whole of the right lung.

R. W., aged 42. Male. Working on tank bogies. Works 12 hours daily for four days and 10½ hours daily for two days. Spends 1 hour daily on travelling. Twelve hours weekly fire-watching. Admitted with right lower lobe pneumonia.

A. B., aged 45. Male. Bricklayer until July 1942, when directed to factory wherein he has worked for 12 hours daily for six days weekly. Travelling time 1½ hours daily. Admitted with lobar pneumonia.

R. W., aged 29. Male. A bomb-sight mechanic working 62 hours weekly. Travelling time 1 hour daily. Home Guard duties 15½ hours each ten days.

In each of these cases I have felt it necessary to advise three or four weeks at a convalescent home after recovery from pneumonia on account of the general ill-health which has been associated with these long hours of employment.

*Pleural effusion.*—This condition is becoming increasingly common in the medical wards, and a typical history is as follows:

M. W., aged 34. Female. Married. Has been working for six days a week for three years with one week's holiday per year. For the last six months she has been doing at least 59½ hours per week. She is generally away from home from 7 a.m. to 8 p.m. each week day; her work is energetic, manual, with a considerable amount of running about, and a little clerical work as well.

#### *An Average Day with Dietary History*

6 a.m. Gets up and has a cup of tea. Nothing to eat.

7.30 Arrives at work.

11 a.m. Cup of tea and bun.

1 p.m. One hour off for lunch. During this time she does the day's shopping and has a cup of tea and roll and butter.

4 p.m. Cup of tea and piece of cake during half-hour break.

7.30 Arrives home and gets meal for herself and two children; but only eats a meal of meat and vegetables on midday of each Sunday. After the meal does the housework, darning, &c., and retires to bed between 12 and 1 a.m.

She has a typical tuberculous pleural effusion, without evidence of gross disease in the underlying lung. There is no family history of tuberculosis.

*Tuberculosis.*—In a ward of the hospital, of 33 beds devoted to this condition, we constantly have eight to ten skilled mechanics or other high grade-factory workers, while on the female side we have an average of six to seven young factory workers. Typical histories are as follows:

G. B., aged 58. Male. Aeroplane fitter at a large aircraft works. No known family or other close contact. Hours of work 7.30 a.m. to 6.30 p.m. with half an hour break for dinner. Seven-day week except for one Sunday a month. Travelling time 1 hour daily. Has had one week's holiday in four and a half years. Now has extensive bilateral tuberculosis, not amenable to treatment.

T. D., aged 15. Male. Tool maker. Has been working in a factory, 48 hours weekly, for twelve months with only one week's holiday. Now has bilateral acute disease, with no known family contact.

A. B., aged 22. Female. Factory worker for five years. Works 7.30 a.m. to 6.30 p.m. on five days weekly and 8 a.m. to 12 noon on Saturdays. Travelling time 40 minutes daily. Diet similar to patient M. W. This patient has extensive bilateral tuberculosis.

A female patient recently under my care, aged 18, asserted that she was the fifth person to become ill with tuberculosis in the small, ill-ventilated, ill-lit factory in which she worked.

*Dyspepsia.*—We have at the moment some seventy beds devoted entirely to the treatment of dietetic cases, mainly gastric and duodenal ulcers.

One factor which is felt to be of importance in the production of these numerous cases is the rapidly changing shift work in force in many of the local factories. The number of new patients, suffering from dyspepsia, attending the out-patient department, has increased by over 300% since 1938, and there is little doubt that much of this increase is closely associated with the factors described above.

I feel that, although the general mortality statistics have not risen unduly throughout

work early and late, and even seize brief holiday periods for essential maintenance work or for planning.

**Conclusion.**—On the whole, the health of the industrial worker of to-day is good. A satisfactory general level has been attained by lowering the standard of the previously prosperous, the "thrivers", in order to raise that of the "strivers" whose employment and therefore nutrition was more precarious in pre-war days. A slight fall in standards of nutrition may perhaps be deduced from the increase in the general incidence of tuberculosis and from an increased tendency towards sepsis following minor accidents (although the loss of time due to sepsis is less) but generally speaking, factory life as such has little specific adverse effect on health. In the larger well-equipped and well-organized factories, hygienic conditions are good; in some smaller concerns and in rapidly expanding factories housed in unsuitable premises, special risks arise, but these are all the time being systematically tackled.

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## Section of Dermatology

President—H. C. SEMON, M.D.

[November 19, 1942]

**Nævocarcinoma (Malignant Melanoma).—J. E. M. WIGLEY, F.R.C.P.**

A woman, aged 66, presents on her left thigh two ulcerated raised tumours, each about 1 in. in diameter, with a number of satellite nodules varying in size from a split pea to a tumour of the same size as the two which have ulcerated. The lesions are of a bluish-mauve colour, are quite firm to the touch, and are not tender. The skin about them appears unaltered. The regional lymph glands are not palpable.

The lesions have been appearing over a period of five to six months, and have ulcerated within the last month. The patient was not aware that there was anything resembling a mole in that region before.

When I first saw the lesions, I thought a diagnosis of hypertrophic lichen planus was probable, though the patient complained of no irritation or other symptoms. She appears very well for her age. Wassermann reaction negative.

**Biopsy of ulcerated lesion:** Towards the outer edge the histological appearance is that of a cellular nævus. There are columns of oval and spherical nævus cells, showing an "alveolar" arrangement, and in places are some nævus cell nests. They do not appear to be continuous with the epidermis. Towards the ulcerated area is a dense infiltration of apparently very similar oval and spherical cells, which in places appear to mingle with the basal layer of the epidermis. In many places the alveolar arrangement of the infiltrating cells is still to be seen. Although some pigment is present, it is not a marked feature.

The case appears to me to belong to the group of malignant melanomata, and the histology suggests its nævoid origin.

Dr. I. MUENDE: This case may prove to be an amelanotic melanotic carcinoma and dopa preparations would be of interest.

Dr. ROBERT KLABER: These nævocarcinomas are not radiosensitive. With or without surgical interference the prognosis is likely to be equally unfavourable.

Dr. H. W. BARBER: Some of those present may have heard Professor Grey Turner's admirable paper on melanoma (Prosser White Oration, *Trans. St. John's Hosp. derm. Soc.*, 1939). His view was that at a reasonably early stage, providing a sufficiently extensive operation was carried out, the prognosis was not unfavourable. The difficulty was to get the early cases. Grey Turner carried out a most extensive operation with a special technique, and it might be worth Dr. Wigley's while to get in touch with him. If operation is to be done at all, it must be done by someone familiar with the operation that he advises.

**Case for Diagnosis. ? Premycotic Eruption.—I. MUENDE, M.R.C.P.**

J. S. M., male, aged 56. This patient was referred to me by Dr. F. S. Airey and Dr. H. A. Korn of Leicester in August 1942.

The eruption is said to have occurred suddenly in September 1941 as a generalized blotchy rash associated with ulcerations of the buccal mucosa, the whole spreading rapidly during the last few months. It seemed to begin as guttate psoriasiform lesions with central dome-shaped keratoses. These enlarge, tend to become crusted, then undergo central atrophy, leaving pigmented, slightly atrophic scars.

He has had bronchiectasis for ten months.

Wassermann reaction, Kahn and Loughlin tests negative. A therapeutic test with intramuscular bismuth and a mercury and potassium iodide mixture tended to increase the number of the lesions rather than to involute them.

Blood-count: R.B.C. 5,070,000; Hb. 86% (Sahli); C.I. 0.86; W.B.C. 4,800 (neutros. 50.5%, lymphos. 34%, monos. 10.5%, eosinos. 5%). Red corpuscles show slight anisocytosis.

**Histological report on tissue removed on August 17, 1942:** The epidermis exhibits a considerable degree of acanthosis, the proliferation being most marked in the interpapillary zone, the suprapapillary layer being relatively thin. The intercellular spaces are widened and show the presence of very numerous migrating lymphoid cells and



the country, many factory workers are now in that low state of health wherein an epidemic of disease, such as influenza, could become nation-wide.

I would point out that these workers are occupying a position in the war effort of equal importance to that of the Armed Forces and deaths which do and will occur among them are just as much a result of war conditions as those occurring from actual combat. In the best interests of the war effort generally and the health of the population I would urge that all factories, and particularly those employed on aircraft and tank production, should be surveyed; that where long hours of work have been the custom for several years a minimum of one week's holiday each three months should be insisted upon, and that a maximum of 56 working hours per week should be imposed except in any exceptional circumstances.

Propaganda should be carried on within the workshops by the medical profession personally, to persuade women that a balanced dietary is essential in the maintenance of effective health and output, for while moderate health may be possible in the home on such dietaries as those above, nothing but catastrophe can be expected if they are continued while on strenuous factory work. As a profession we should stress all possible preventive measures and should not be content to wait until catastrophe happens before exercising our art.

**Dr. Dagmar Wilson :** A comparative survey of women industrial workers and of women of the same age-groups at home or otherwise employed, suggests that two important factors influence the level of their health and nutrition, the woman herself, her former health and the degree of adjustment to her present environment; and the conditions of her employment, including hours of work. The well-balanced woman factory worker faces without complaint, an extension of the normal eight-hour working day and the addition of night shifts, in the same spirit that the housewife, content to help in the war effort, meets the physical and mental strain of wartime housekeeping, the care of evacuated children, and of strangers billeted on her. Such women when questioned may admit of fatigue and nervous tension, but on examination the majority do not give indication of ill-health as evidenced by signs of vitamin deficiency. In both groups there is a smaller number of women, some giving records of previous disease, others with less definite history of lack of well-being. These women, whether in or out of factory life, fail to meet the demands of wartime employment; this is evidenced subjectively by complaints such as dyspepsia and headache, and objectively by abstention from wartime duties. Amongst them there is some evidence of malnutrition associated with signs of vitamin deficiency. More are found among industrial workers since it is easier for these outside factory life to moderate their hours of work.

Because women are conscripted into industry, it is important to appreciate from the viewpoint of preventive medicine, the very different types of environment in which they may be called upon to work. From the women's health aspect, factories fall into three groups:

(1) Factories which pre-war employed large numbers of women workers and provide accommodation and facilities adapted to their special needs. They have a well-trained supervisor of women's personnel. Such a welfare worker is able to study the women employed and in many cases to fit them with the job most suited to their ability. In these well-run factories monotony and the depressing effects on health of blackout are reduced to a minimum. Works doctors are also available who understand industrial conditions. Adequate canteen facilities are provided.

(2) Factories which pre-war employed little or no women's labour and which have been rapidly extended and may be housed in ill-adapted buildings. Often it has not been possible to obtain a fully trained woman welfare officer. Canteen arrangements may not be satisfactory.

(3) There are numerous small factories where, pre-war, men only were employed. These have not the financial background of larger works and the conditions to which conscripted women are subjected may be far from satisfactory.

Women in the last two groups may not have the advantage of medical supervision of a works' doctor trained to appreciate industrial risks. They seek the aid of already overworked practitioners some of whom have never been inside the factory and have no personal knowledge of the conditions under which women are employed.

cases have been demonstrated or described by Graham-Little, Dore, Beatty and Speares, and myself. On the glabrous skin the eruption is usually of the lichen pilaris or plano-pilaris type. On the scalp, and sometimes in the axillæ and on the pubic region, follicular, horny papules are seen, and these are followed by atrophy of the follicles with consequent alopecia. There may be typical lichen planus of the buccal mucosa. Forman and I have observed cases of this type occurring after injection of metallic salts, such as bismuth and gold.

#### Discoïd Purpuric Pigmented Eruption.—ROBERT KLABER, M.D.

A young married woman, aged 29, for the last two months has had a macular eruption, most marked on the buttocks and thighs, and less extensively on the front of the arms and forearms, the backs of the knees, and the dorsum of the foot. The size of the lesions varies from that of a pinhead to a shilling. Mostly they are flame-coloured (orange-scarlet), with a purpuric or telangiectatic element still visible on glass pressure. There is no irritation, and the patient has good health otherwise, except for occasional headaches, which are unilateral, though not associated with any other symptoms of migraine. For four or five months, about twice a month, she has taken a tablet of anadin, which is said to contain three grains of phenacetin, three of aspirin, with a little caffeine and quinine. The eruption has some of the features seen in cases resulting from adalin. I have not previously seen any eruption of this kind associated with phenacetin. I have included two similar cases here some years ago (*Proceedings*, 1934, 27, 815 and 1032) as atypical examples of Schamberg's disease and have seen others here and elsewhere. Further experience suggests that such cases do not strictly belong within the confines of Schamberg's disease or Angioma Serpiginosum. They form a quite distinct if still nameless group showing some of the features of each of these diseases.

#### Elephantiasis of the Ears, in a Non-boxer.—GEOFFREY DUCKWORTH, M.R.C.P.

For more than three years J. B., a gas worker, aged 34, has noticed thickening of the ears with an itchininess of the skin and periodic weeping. When first seen a few months ago, the ears were impetiginized and very swollen; in places, such as behind the lobes, lobulated swellings were present. At the present time both ears show conspicuous œdema—lymphatic in type—and the lobulated swellings persist.

J. B. has never boxed and never remembers having been in any brawl, when his ears might have been struck. The Wassermann reaction is negative. No improvement followed a course of sulphathiazole. Definite improvement followed the application of 1% gentian violet in 25% industrial spirit.

The condition is apparently due to lymphatic obstruction resulting from a streptococcal invasion.

THE PRESIDENT: I have had one or two similar cases. Such a condition can be labelled streptococcal lymphangitis. Treatment by X-rays will do more than local applications or internal medication with the sulphonamide group.

#### ? Schamberg's Disease.—A. MURRAY STUART, F.R.C.S.

Man, aged 47, treated for secondary syphilis in 1919. He then received 8.7 g. neo-kharsivan. His Wassermann reaction remained negative for a year and he was told that he needed no further treatment.

He remained well until 1938 when an eruption appeared on the legs and spread to the buttocks, flanks and arms. The lesions first appear as groups of pin-point reddish spots. The patches slowly enlarge and become pigmented. Fully developed patches present a brownish pigmentation. They are not raised. The skin feels a little roughened. Individual patches have cleared up but others have appeared and he has never been clear since.

I first saw him in June 1939 when I found his Wassermann reaction was strongly positive. Since then he has had 36.3 g. neoarsphenamine and 15.2 g. of bismuth. The Wassermann reaction remains unaltered and the skin lesions have been quite unaffected.

*Biopsy* (Dr. Freudenthal): The main change is a fairly dense infiltrate in the upper part of the cutis, arranged in patches. These patches are localized around a great number of newly formed capillary vessels. There is an œdema in the papillary body, the epidermis is spongiotic in places, and there are a few parakeratotic nuclei in the otherwise unchanged horny layer. A small amount of melanin is present, also traces of hæmosiderin.

The presence of melanin and hæmosiderin tends to confirm my diagnosis of Schamberg's disease. Against the possibility of the lesions being due to syphilis is the fact that intensive treatment has left them quite unaltered. Parapsoriasis is another possibility but marked pigmentation is unusual in this condition.

polymorphonuclear leucocytes which tend to collect in the more superficial layers of the rete malpighi. The stratum granulosum is absent and the stratum corneum is replaced by a very thickened layer of nucleated horn cells embedded in a considerable amount of coagulated serum. The pars papillaris is oedematous, its capillaries being dilated and the tissue densely infiltrated with numerous small lymphoid cells and hyperplastic connective tissue cells.

Dr. W. FREUDENTHAL: This case shows a great variety of lesions: psoriasiform, eczematoid, lichen-planus-like. There are also lesions consisting of a small, circumscribed cutaneous infiltrate showing no changes or very little change in the overlying epidermis. I think it is primarily a cutaneous disorder of the reticulosis group, perhaps a premycosis.

Dr. H. W. ALLEN: The size of the individual lesions is significant. The typical lesions of lichen planus hypertrophicus are seen on the backs of the hands.

Dr. ELIZABETH HUNT: I have recently seen a similar condition in a woman with a ten days' history of a very irritating rash on the forearms, lower parts of the thighs and the soles. At the last site there were typical lichen papules; elsewhere the condition suggested a guttate psoriasis eruption, but the scales were adherent and the bases of the lesions had a deeper purplish hue than one sees in psoriasis. I could not make a definite diagnosis.

Dr. J. E. M. WIGLEY: Many of the lesions in this case seem to me characteristic of ordinary psoriasis and I should be chary of labelling the case by any other name.

Dr. A. C. ROXBURGH: I agree with what Dr. Wigley has just said.

Dr. MUENDE: It is difficult to associate psoriasis with the ulceration of the mouth. I agree with Dr. Freudenthal that the epidermal effect is secondary. It is only when the infiltration reaches a certain size that the epidermal changes become significant.

#### Pseudopelade (Brocq) with Involvement of the Beard Area.—I. MUENDE, M.R.C.P.

A. J., male, aged 58. *Past history*.—A few pustules appeared on the scalp about twelve months ago; these soon led to the formation of a carbuncle which, on healing, resulted in the local loss of hair.

He was first seen by me two years ago when he had extensive pseudopelade (Brocq) involving about three-quarters of the whole scalp and slight perifolliculitis of the pubic hairs. Examination of the urine revealed marked glycosuria and later investigations confirmed the diagnosis of diabetes. During the last twelve months the scalp lesions have extended and he has developed similar patches over the right ramus of the jaw.

Dr. H. W. BARBER: I think this case is one of lupus erythematosus of the scalp, with patches on the face and neck. There still seems to be confusion between pseudopelade, folliculitis decalvans, the severer forms of keratosis pilaris, and lichen planus with cicatricial alopecia.

Dr. Muende's case is certainly not one of pseudopelade. That condition begins as small oval or irregular bald patches, arranged close together. These patches are cicatricial and sharply defined, with a smooth wax-like surface. Their follicles have been destroyed, but no scales, horny plugs, broken hairs, or telangiectases are seen. By confluence of adjacent patches relatively large areas of cicatricial alopecia may result, but the outlines of the original components can usually be distinguished. The vertex of the scalp is as a rule first affected. Although the sclerosis is secondary to an inflammatory process, clinical signs of inflammation are absent, except that at the edges of the patches may be seen faint, rose-coloured haloes around the hairs that are doomed.

Folliculitis decalvans, so often confused with pseudopelade, is an entirely different condition, both clinically and aetiological. Folliculitis decalvans begins as a single patch, usually on the vertex. The centre is cicatricial and bald, and at the periphery are hairs which at the mouths of their follicles reveal red inflammatory points, sometimes with actual pustulation. I think that folliculitis decalvans is comparable to the cicatricial form of sycosis barbae and, like it, due to infection with *Staphylococcus aureus*. This organism alone has been recovered on culture. In pseudopelade no organisms have been isolated, and the histology suggests that a blood-borne toxin is responsible.

Two other conditions—the severe form of keratosis pilaris (k.p.atrophicans) and lichen planus, usually of the pilaris or plano-pilaris type, with cicatricial alopecia—have also been confused with folliculitis decalvans and pseudopelade. The former is clearly a congenital anomaly allied to or a variety of ichthyosis. Cases have been recorded in which one or other parent was ichthyotic. The condition labelled by Taenzer ulerythema ophryogenes is merely part of this abnormality. In severe cases the scalp may in time become almost bald, and the eyebrows and eyelashes are lost.

The association of lichen planus with cicatricial alopecia is well recognized, and

In the adult type the explanation of these observations is to be found in a special dysfunction of the liver which we were able to verify by a number of clinical facts and laboratory findings. Barber (1932) describes two illustrative cases.

To these I can add from my personal experience other cases which developed light-sensitivity after obviously suffering from liver disorder. [Full paper to be published.]

In veterinary medicine as well as in research work the connexion between liver damage and light sensitization is very clearly indicated. Geel-dikopp, a cattle disease occurring in South Africa which renders the animals light-sensitive, is caused by allowing the cattle to feed on certain plants, especially *Tribulus* and *Lippia*. The work by Rimington and Quin revealed that the light sensitization was brought about by the action on the liver of certain toxic substances contained in these plants. The poisonous substances caused a well-marked jaundice and this hepatic disturbance, according to the authors' opinion, must be looked upon as fundamental to the development of the symptoms of light-sensitization and its skin manifestations. In pursuing their researches Rimington and Quin showed that even liver damage caused by experimental obstruction of the main bile ducts, e.g. the ligation of the common duct, was able to produce severe sunlight sensitization with all its consequences on exposure to the sun.

During the attacks of eczema the urine of the patients regularly showed an increase in indican and especially urobilin, often in abundance, so that the urinary output of bile pigment exceeded that in the faeces—an unmistakable sign of liver damage. A marked cholesterolemia was always present, sometimes accompanied by a decline of cholesterol esters in the blood. The galactose tolerance test also showed liver deficiency. Finally, as was first shown by Barber and his collaborators, light-sensitive patients (adult type) have abnormal bacterial flora in the faeces and symptoms of liver deficiency attributable to absence of normal bile in the intestine.

Querner has shown that livers of animals partly exposed to ultraviolet or X-rays and partly protected against those rays exhibited a complete disappearance of the vitamin A in the liver cells thus exposed. Earlier experiments undertaken by the writer make it clear that the liver cell always contains vitamin A, which it needs for its normal functioning. The toxic influence of thyroxine on the liver which leads to a complete disappearance of glycogen from the liver cells, can be successfully counteracted by administration of vitamin A, and glycogen storage can thus be achieved again. In severe Graves' disease and in the experimentally-produced thyrotoxicosis by administration of thyroid gland, the liver cell completely loses its glycogen; this can be prevented by administering vitamin A. Moreover, vitamin A has been shown essential for the formation of normal bile. If vitamin A is lacking the bile loses its stability of suspension and precipitations occur leading to gall-stone formation. That vitamin A has a marked influence on the epidermal layer of the skin is shown not only by the cutaneous signs of vitamin A deficiency, but also from the good effects of the vitamin on healing wounds.

In view of this connexion between liver and skin and vitamin A, various preparations of vitamin A were employed in attempts to eliminate light-sensitivity. External application of vitamin A oil or ointment caused considerable irritation. Subcutaneous or intradermal injection also produced marked eczematous reactions closely resembling those precipitated by exposure to sunlight. By processes of elimination it was found that comparatively crude natural esters of vitamin A as well as the solvent (arachis oil) employed would produce similar reactions. Eventually it was found, however, that highly refined preparations of natural vitamin A esters in butyl or ethyl phthalate produced little or no eczematous reaction but still contained the factor producing immunity against photosensitivity.

I therefore undertook to try a number of fractions. Finally a product known as L.C. 227 (British Drug Houses Ltd.) was tried and found not only to be therapeutically active, but its injection produced no untoward effects.

#### DISCUSSION

Just as the rashes following exposure to sunlight do not produce an immunity to the rays, the artificial reactions are not followed by immunization; on the contrary, the severe rashes increase the susceptibility. It was also possible to produce an outbreak on the skin of light-sensitive patients which resembled in every respect the original eruption. Moreover the rash only occurred on the exposed parts. This latter observation is comparable to a well-known experiment by Bloch (1913).

We must therefore assume that the rays of the sunlight activate a toxin most probably of intestinal origin—which escapes destruction in the liver. As in Bloch's experiment, in our cases only the sensitized areas reacted to the injections. In other cases of eczema the injections provoked more generalized reactions, areas not previously eczematized being involved. Moreover, our results can be regarded as a support of the opinion of Rich (1933).

Dr. J. E. M. WIGLEY: Many of the lesions appeared to me exactly like those which Dr. J. M. H. MacLeod has demonstrated to me personally as "Parakeratosis Variiegata". In his textbook (*Diseases of the Skin*, J. M. H. MacLeod, p. 847) he places this in the retiform variety of parapsoriasis, which is the diagnosis I should apply to this case.

Dr. A. C. ROXBURGH: I considered the case much more like parapsoriasis than Schamberg's disease. In the latter one does not find all the alteration in the texture of the skin which is seen in this case. I should have described it as parapsoriasis.

**Papulonecrotic Tuberculides and Old Tubercular Keratitis.**—HENRY C. SEMON, M.D.  
(President)

A young Jewess, aged 22. Except for the cicatrices of healed lesions of many recurrent attacks over fourteen years, she has only one active necrosing papule at present, which can be seen on the dorsum of the proximal phalanx of the left ring finger. There are many pitted scars over the knuckles of both hands—a common site for this disease. Last year when I saw her with Mr. E. Wolff, the ophthalmologist at the Royal Northern Hospital, she exhibited active lesions of similar type in both nasomaxillary grooves, close to the alar cartilages, behind both ears, under the breast, and a few on the scalp. She was having treatment for the keratitis, which affected both corneæ and caused an extreme degree of lacrimation and photophobia. The two circular depressed scars on the flexor aspect of the right forearm are the sequelæ of two Mantoux tests—the most vigorous reactions I have ever encountered. Radiographic examination of the chest proved negative although apical infection had been reported. The cutaneous manifestations appeared to involute after three injections of solganol B oleosum, but the sequel may well have been "post" rather than "propter hoc", for as in the present small relapse, previous nodules had tended to heal spontaneously in from two to three weeks. The treatment had no effect on the keratitis which proved refractory to all the usual local and general measures, including diathermy, tuberculin and general ultraviolet ray therapy. The symptoms eventually responded to the fever induced by small intravenous doses of T.A.B. vaccine (for protein shock), 50-100 million at ten-day intervals. There was one other unusual feature: in the left frontal area there was a definite and localized patch of alopecia. It was diffuse and not complete. There were no stumps or anything else suggesting alopecia areata, and there was no scarring or atrophy. Dr. Barber, a year or more ago, suggested the possibility of lupus erythematosus, but I think the complete recovery of the hair has put that possibility out of court.

I was particularly interested in this symptom because some five years previously my house physician requested treatment for so-called alopecia symptomatica and after three months without improvement, she suddenly developed a genital form of tuberculosis and eventually succumbed to the disease.

## Solar Dermatitis in Adults. [*Abridged*]

By A. ADLER, L.R.C.P., L.R.C.S.(Ed.)

THE first systematic investigation on lesions of the skin caused by light was made by Barber, Howitt and Knott (1926). Bazin, Hutchinson, Adamson, Fox, Crocker and McCall Anderson had earlier reported a number of cases which, however, had not been thoroughly investigated.

Photosensitivity of the skin may be so pronounced that the patient may be compelled to live in a dark room because the skin reacts by becoming swollen and red (in patches) and inflammation may proceed to blistering and ulceration. Deep folds and cracks also may appear.

The primary cause of the disease is, at present, unknown. It seems to be an allergic susceptibility of the skin to sunlight. According to Barber there are two groups, a juvenile type in which the disease dates from earliest childhood (hydroa-vacciniforme or æstivale) and an adult type which first appears after 20 years of age. In the juvenile type, the sensitizing agent is hæmatoporphyrin and the condition is therefore a type of hæmatoporphyrin congenita. From my own more detailed examination of the adult type it is evident that faecal porphyrin, which is not infrequently present, is not the cause of the skin eruptions. Urinary porphyrin is never present in these cases. Further, in the adult type the skin lesions (in contrast to the juvenile type) are always superficial, confined to the epidermis and never show scarring after healing. A marked hypochlorhydria (or even achlorhydria) is often present as well as abnormal bacterial flora of the feces resulting in indicanuria.

or alternatively an atypical granuloma annulare. Dr. Gray agreed that this should be considered.

In 1938 she consulted me, and I regarded the case as one of atypical lichen planus of the obtusus type (not, of course, the so-called lichen obtusus corneus, the term formerly applied to prurigo nodularis). There were on the backs of the hands scratch-lines with flat papules which closely resembled those of lichen planus, and I erroneously thought that these clinched the diagnosis.

In 1942 the eruption had spread considerably and was a characteristic example of *lichen ruber moniliformis*, or, as Wise and Rein call it "*morbus moniliformis lichenoides*" (*Arch. Derm. Syph.*, Chicago, 1936, 34, 830), for now the characteristic moniliform arrangement of the papules was evident on certain areas, notably the wrists, lower forearms, and ankles.

The clinical picture is very striking. The distribution is more limited than in the case described by Wise and Rein (a male aged 38), the limbs only being involved. Two features deserve special emphasis—the exact symmetry, and the fact that wherever the papules occur there is a bluish discoloration of the skin due presumably to capillary stasis. This affects the backs of the upper arms and forearms, the hands (the papules are present on the palms and sides of the fingers as well as on the dorsal surfaces), the lower thighs, and the legs. Here and there in the bluish areas are clear islets of white skin with no papules. This bluish condition of the skin is comparable to that so frequently seen in females, particularly in adolescent girls, on the legs and upper arms; associated with increased deposition of subcutaneous fat and keratosis pilaris (*erythrocyanosis crurum puellaris*). In these cases there are often definite pads just above the ankles due partly to fat and partly, I think, to lymphatic stasis. Similar pads are well seen in this patient.

The elementary lesions vary in size and in colour apparently according to their age. They are raised papules, firm, somewhat resilient to the touch but not "shotty". The more recent ones, as exemplified by those on the deltoid regions and near the posterior axillary borders, are pale-yellow and waxy-looking. The older ones, which, I think, are situated chiefly on the areas that are bluish-red in colour, are themselves dark red. The lesions are for the most part very closely aggregated, forming in some parts a mosaic pattern and in others the characteristic moniliform chains. In places, however, they are more discrete, for example on the elbows. It would seem that the oldest papules flatten down and tend to disappear spontaneously. This has occurred, for example, on the dorsal surface of the feet.

An examination of the blood showed some degree of simple anaemia. The differential leucocyte count showed a slight relative lymphocytosis. There was no eosinophilia.

*Histology* (Dr. W. Freudenthal).—The papules are marked by areas of apparently rarefied connective tissue which stains only faintly with eosin. When stained with thionin according to Hoyer these areas show an extensive, dense, fine-fibrillary net-work stained metachromatically pink, thus indicating the presence of mucin.

Regarding the classification of this condition Wise and Rein quite rightly came to the conclusion that it was not a lichen planus, but a "*morbus*" of its own. I think we are entitled to include our case of lichen moniliformis in the myxoedema group. It might be termed "*myxoedema moniliforme*" and be regarded as a variety of myxoedema papulosum. (This case will be published later in full.)

Dr. F. PARKES WEBER: I think the general appearance and the history of this case point to some endocrine disease, and what endocrine disease can one think of as more likely than some abnormality in thyroid function? In spite of the lack of exact evidence I believe that a dysthyroidosis, not necessarily a hypothyroidosis or a hyperthyroidosis, will prove to be at the root of the trouble.

Dr. H. W. BARBER: I am in agreement with Dr. Parkes Weber that some endocrine disturbance is primarily responsible for this condition. Dr. P. M. F. Bishop did not think it necessary to investigate the basal metabolic rate. He considered that oestrone, rather than thyroid-deficiency was present. The patient has already taken thyroid.

Lieut.-Col. D. M. PILLSBURY (U.S.A.M.C.): This case seems to correspond very well with that reported by Wise and Rein. There may be a possibility of amyloidosis in this patient, and I would like to suggest that intradermal tests for amyloid with congo red be done.

Dr. BARBER: Wise and Rein did stain for amyloid in their case, but without success.

*Periarteritis Nodosa*.—G. B. DOWLING, M.D. (Shown by EVAN JONES, F.R.C.P.).

Boy, aged 15. For past year has had nodules on arms, shoulders and hands. They commenced while he was in hospital with an attack of rheumatism with swollen joints.

who opposed Cranston Low's (1924) conception of allergy being regarded as an attempt at ridding the body of the infecting agent. The best immunity can be brought about where the least allergic reaction is produced (Rich and McKee, 1934). We find the same in our cases: the less reaction the better the improvement.

Now the fact that reactions with these vitamin A ester preparations were not only obtained in light-sensitive eczema but in ordinary eczema as well shows that the antigenic factor in the preparation is not strictly specific. Barber in a paper on the significance and pathogenesis of certain dermatoses draws attention to the production of autogenous antigens in the body to which sensitization might develop; the primary antigens being multiple and often of different source. Functional deficiency of the liver must be regarded as the main centre for the formation or non-destruction of the secondary autogenous antigens well in conformity with Mainwaring's experimental result of deriving anaphylotoxin or secondary antigen from the liver as the cause of anaphylactic shock in sensitized dogs.

In practically every patient treated in the course of this investigation the reactions disappeared and healing began as soon as the preparations used were highly purified. Most probably the effect was due to their enabling the liver cells to deal properly with the autogenous antigens. When this recovery of the liver had been slowly achieved, even preparations previously causing violent reactions were well tolerated. What is it in the preparation that achieves the desired result? It is most unlikely that it is the vitamin A since vitamin A alcohol and synthetic vitamin A esters have no curative effect. On the other hand oils like olive and arachis oil which were used as solvents gave reactions by themselves. We are therefore forced to assume that it is a certain factor always accompanying vitamin A esters in nature in minute doses that is responsible for bringing about the good results observed.

I want to thank Dr. Barber who kindly gave me every facility to carry out this work in his Department at Guy's Hospital.

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[January 21, 1943]

**Lichen Ruber Moniliformis (Morbus Moniliformis Lichenoides: Wise and Rein; Myxœdema Moniliforme: Freudenthal).**—P. B. MUMFORD, F.R.C.P., and H. W. BARBER, M.B. (Case shown by Dr. H. W. BARBER).

Mrs. M. H., aged 45. No children. In 1924 she began to suffer from rheumatic symptoms and an erythematous eruption. She later developed an eruption on the hands (? eczematous), which lasted for six months.

The existing eruption has been present for about six years. It appeared first around the ankles, the localization apparently being determined by the pressure of the shoes. Later the legs became involved, it was thought from pressure by gaiters and stirrup-leathers. The backs of the hands, wrists, and elbows were subsequently affected, and more recently the eruption has spread to the upper arms, forearms, palms, and thighs. Apart from the apparent effect of pressure, it was noted that, as in lichen planus, lesions appeared in scratch marks.

Two years ago she sustained a Pott's fracture of the right ankle. After this she began to suffer from pain and swelling of both ankles, and stiffness with some tenderness and swelling of the fingers. She also appears to have had some infection of her urinary tract, presumably due to the *Bacillus coli*.

In 1937 Dr. Mumford considered the diagnosis of xanthomatosis, but the blood cholesterol was almost normal. A glucose tolerance curve was also within normal limits.

She also saw Dr. A. M. H. Gray in 1937, who at first thought that the eruption might be a circumscribed myxœdema of the papular type, and noted that her appearance was somewhat suggestive of generalized myxœdema. Dr. Freudenthal to whom a section was submitted, suggested the possibility of a papular myxœdema on histological grounds,

three firm, dome-shaped papules about 1 cm. in size. There are no subjective symptoms. *Previous history.*—He had a hæmoptysis in 1939, and was sent to Switzerland. He was considered cured in 1940 and went back to his work. He soon had another hæmoptysis, and was found to have a cavity in the right apex. He was treated at Midhurst by artificial pneumothorax and phrenic avulsion. In 1942, he developed a pleural effusion and went to the Osler Pavilion, Oxford. Fluid is still present. He does no work, but otherwise leads a normal life.

*Pathological examinations.*—Sputum: Though examinations have frequently been done, they have been found positive on only two occasions since 1939.

Wassermann and Kahn reactions negative.

*Biopsy:* Dr. A. H. Robb-Smith and Dr. W. Freudenthal, examining the sections, found collections of giant cells, more suggestive of a foreign body granuloma than of a tuberculosis. Many of the giant cells have enclosed in their cytoplasm one or several small round particles, which under the polarizer show double refraction as e.g. silica particles do. They disappear, however, by micro-incineration.

*Comment.*—The question of silica is interesting, as the man is a mining engineer, and has spent his life in Australia, Burma and the Gold Coast, though mostly engaged in mining gold and tin from alluvial sources, and only for a short time in 1911 in hard rock underground gold mining. The report of the radiologist, Dr. Kemp, is that the lung picture is not incompatible with silicosis. Skin lesions due to blood-borne silica have, as far as is known, never been described.

Dr. W. FREUDENTHAL: Silica particles in the skin may give rise to a pseudo-tuberculous granuloma. Perhaps Dr. Carleton will have an opportunity to investigate other lesions and to find out whether they also contain doubly refractive bodies and what their nature is.

Dr. I. MUENDE: May I suggest another diagnosis, namely, tuberculoid leprosy. This man has been living in areas where leprosy is endemic and, besides the suspicious tuberculoid lesions, he has numerous nodules on the tongue and buccal mucosa. These cases have been observed and investigated very thoroughly by Wade whilst working in the Philippines. The histology, in my opinion, lends support to the diagnosis. Although bacilli are not present in the tuberculoid lesions they may be found in the nodules.

Dr. PARKES WEBER: Are there any recorded examples of lesions of this annular type due to silica? One would have thought that if silica did travel in the blood circulation to the extremities, it would produce single papules, not annular lesions. I cannot understand the formation of a spreading ring with healing in the middle through local holding up of silica in the capillaries of the skin.

THE PRESIDENT: I think the diagnosis in this case might be assisted by a Mantoux test. If the patient proves hyperallergic it would favour the tuberculous nature of the lesions. I have such a case in hospital at the moment. She has a papulonecrotic type of tuberculide on the back and chest and several large plaques with an ulcerating tendency on the legs and both elbow regions. The biopsy was not conclusive of a tuberculous aetiology, but the Mantoux test was strongly positive and resulted in local necrosis and a focal reaction in all her lesions. A further point of interest was the temporary effect of a single intravenous injection of a gold salt—sancrocrin 0.05 g. The reaction was alarming. Pyrexial polysynovitis affecting the wrists and knees mainly, ensued the following day, and persisted for a week. When this subsided a marked improvement in the skin lesions was noted. As far as could be ascertained by auscultation and X-ray examination there were no tuberculous foci in the lungs, and there was no history of adenitis at any time. The patient had nursed for some time in a sanatorium.

#### Circinate, Linear Eruption on Face.—A. C. ROXBURGH, M.D.

Mrs. N., aged 32. Patient of Dr. A. Coleman, Croydon. *History.*—Married eleven years, one daughter, aged 4. About May 1942 a small red patch was noticed in the suprasternal notch. This gradually extended into a line which, when first seen on December 8, 1942, formed a V in front of neck extending as a faint red line up the sides of the face just in front of ears, over the temples and across the forehead just below the hair margin. There was a separate, but exactly similar, ring on the upper and lower eyelids around each palpebral fissure, and another around the mouth. The latter is believed to have started from each angle of the mouth. There was a fifth small ring underneath the chin. The line consisted of a slightly red, slightly raised, slightly scaly continuous ridge about 2 mm. wide. There was no alteration in the texture of the skin over which the eruption was said to have passed. The eruption itched only when hot. Dr. Coleman had had a Wassermann done, which was negative. I made scrapings from several parts of the line but could find no mycelium. I then gave on December 8, 1942, 100 r of X-rays



He was in hospital for nine months, fairly well but for slight pyrexia. When the nodules first appeared they were red and tender and as time passed they became bluish. He now has a blue mottling over the greater part of his body except the chest. The nodules, or lumps, are still appearing.

Apart from the skin, there are no symptoms. The cardiovascular and other systems are normal.

*Other investigations.*—X-ray of the chest, the Mantoux test, electrocardiograms, three or four blood cultures and cerebrospinal fluid examined on three occasions—have shown nothing abnormal. One of the nodules was excised and showed a perivascular infiltration with eosinophil cells.

We came to the conclusion that this was a case of periarteritis nodosa.

Dr. F. PARKES WEBER: Periarteritis nodosa is one of the diseases which are much under discussion nowadays. There is a considerable literature bearing on the subject. The present case is anatomically a case of periarteritis nodosa; under the microscope one sees nodules of periarteritis or periarteriolitis. A few chronic cases—as evidenced by biopsy—have I believe been recorded with ultimate recovery.

Dr. H. W. BARBER: I took a case into Guy's at the request of Dr. Geoffrey Evans. It had been extensively investigated. He suffered severely from a generalized prurigo. I should have thought that, clinically, it was a case of Hodgkin's disease, but he had an eosinophil count of over 50% and he was labelled as a case of eosinophil leukaemia. I asked Dr. Douthwaite to see him and he said that the diagnosis lay between Hodgkin's disease and periarteritis nodosa. He thought if one cut sections of certain organs one might find the typical histological features of the latter disease. I do not know much about periarteritis nodosa, but I should have thought that the eosinophilia was too high.

Lieutenant T. W. MURRELL, Jr. (U.S.A.M.C.): In an American hospital we have a case diagnosed as periarteritis nodosa in which mild skin lesions are present. He is a coloured man, aged 37, who has been a cook on active duty for about five years. About three months ago he noticed mild swelling of his legs, particularly the calves, and about two months ago pain in the muscles of the calf and some progressive swelling. He is very particular what he eats and his diet has been deficient in many ways. He was sent into hospital mainly because he had this slight swelling of the legs. He also had some nodules on the lower part of the legs and the calf muscles were painful on pressure. We were interested also to note that he had pain in the muscles of the forearm. We considered the question of vitamin deficiency. He had an eosinophil count of 9%. He has now developed renal insufficiency, and the nodules on the calf show a typical picture of periarteritis nodosa. He has polyneuritis, which I happen to have seen in two other cases. We have not yet seen in this case, which may be fairly typical, any skin lesions apart from a mild erythema.

Dr. C. H. WHITTLE: I saw a case of Professor Ryle's of periarteritis nodosa in which there were certainly no cutaneous lesions present. The features, as far as I remember, were continued bouts of fever with a suspicion of endocarditis. Blood cultures were, however, repeatedly negative.

I would like to ask Dr. Evan Jones if he can throw any light on the endarteritis which is present, at any rate in one of the arteries he was showing in one of the sections: Is endarteritis as well as periarteritis a feature of the disease?

Dr. EVAN JONES: This happens to be the fourth case I have seen in six months. The cause of the disease is unknown. About 70% of the cases run a febrile course, and show lesions around the small and medium-sized vessels. The lesion starts around the periphery of the vessel with a polymorph and eosinophil infiltration. Later on it spreads into the media, and then aneurysms may develop. Some of the nodules in the skin may be due to aneurysms. They are not uncommon on bigger vessels, and the organs which are commonly affected are the kidneys, heart, liver, spleen and central nervous system and sometimes the peripheral nerves. Any organ in the body can be involved in periarteritis nodosa. Later on there is involvement of the intima with clotting, which diminishes the blood supply to various organs. Most of the patients who have periarteritis nodosa end with renal insufficiency. As far as I can gather from the literature, authors are prepared to give figures for different organs, but I cannot find any percentage incidence of skin lesions; they say skin lesions are sometimes erythematous, sometimes papular, but they give no percentage.

**Case for Diagnosis.** ? Annular Tuberculide. ? Cutaneous Silicosis.—ALICE CARLETON, M.B.

A. W. R., a man, aged 63. On chest, back, arms and legs are numerous oval, annular lesions with central atrophy, and marginal apple-jelly coloured papules. They first appeared in 1941 as small papules, about  $\frac{1}{2}$  cm. in size, and a year later they had enlarged and become annular. On the inside of the cheek and on the dorsum of the tongue are

apparent. The patient himself had never noticed them before. A biopsy performed by Major J. H. Twiston Davies, shows the typical changes of the elastic tissue (elastorrhexis



*Pseudoxanthoma elasticum.* Broken-up elastic fibres encrusted with calcium salts.  $\times 40$ .

and elastoclasia). By v. Kossa's silver nitrate method these broken-up elastic fibres of the lesions are found encrusted with calcium salts.

The prognosis for vision is unfavourable in a high percentage of this condition. The patient was boarded out of the Army.

**Urticaria Pigmentosa in an Adult (Telangiectasia Macularis Eruptiva Perstans, Barber and Parkes Weber Type).—L. FORMAN, M.D.**

Mrs. H., aged 22. At the age of 15 years, discoloured patches noticed on chest, arms and legs. During the past two years, lesions have spread to involve the greater part of the face. Healthy woman, menarche at age eleven, normal. No abnormality on general examination. On the legs there are numerous reddish-brown lesions becoming somewhat irritable and more red when warm. On the thighs, the macules are redder, and show some telangiectatic vessels on compression. On the arms, there are numerous telangiectatic lesions. On the chest, there are a few brown lesions and a number of pale brown macules on the back. Over the face is a network of pinkish-brown macules.

The wide distribution over the face and the telangiectatic character of the lesions recall the type described by Barber and Parkes Weber.

**Urticaria Pigmentosa with Unusual Atrophy, in an Adult.—L. FORMAN, M.D.**

Mr. G. L., aged 36. Had been under treatment for acute articular rheumatism with fever; this had subsided when he came under observation. Skin lesions had been present for five months, and the rheumatism had occurred a month after the onset of the rash.

He showed some 25 areas, mainly on the trunk with a few on the proximal parts of the thighs and the upper arms. They varied from  $\frac{3}{8}$  in. across to older ones  $1\frac{1}{4}$  in. across. The smaller lesions were bluish in colour, a little raised from the surface and becoming more prominent and red when rubbed. They were occasionally irritable and showed some exaggeration of the follicular orifices, suggesting some oedema of the upper part of the cutis. The larger areas had a yellowish tinge or were white in colour, recalling

to the muzzle area and a 3% salicylic and benzoic acid ointment. When seen again on December 31, 1942, the line across the forehead had descended to 1 in. below the anterior hair margin and had become irregular with a loop descending nearly to the left eyebrow at its inner end. A new loop had appeared around each angle of the nose. The area X-rayed was less obvious than it had been and the eruption was less irritable all over but much the same otherwise. Ammoniated mercury ointment was then prescribed and another 100 r of X-rays given to each side of the muzzle. Since then I have not seen her until to-day. I have thought of syphilis, psoriasis, tinea, and erythema annulare centrifugum as possible diagnoses, but none seems really to fit the case.

Dr. F. W. JACOBSON: I wonder whether the patient has ever taken phenolphthalein?

Dr. ROXBURGH: I have not asked her, but it is not like any eruption from phenolphthalein that I have ever seen.

Dr. BARBER: I should have thought that this was an erythema annulare centrifugum of the Darier type.

Dr. W. FREUDENTHAL: The case reminds me of Dr. Brain's case of ? granuloma annulare shown at the meeting of May 18, 1939. (*Proceedings*, 32, 1403.)

Dr. ROXBURGH: I have referred to the "Corpus Iconum Morborum Cutaneorum" but I cannot find an illustration really like this case.

Dr. PARKES WEBER: The fact (according to Dr. Roxburgh's clear account and the patient's own evidence) that the lines did shift their positions suggests after all the possibility of an erythema centrifugum of Darier's type, although the case appears unique.

Dr. F. SHERRY-DOTTRIDGE: I think the case is very similar to Dr. Brain's which began under the chin and spread out on to the chest. I remember seeing that case a few months ago and, although the narrow margin had extended, the eruption was fading.

Lieut.-Col. D. M. PILLSBURY (U.S.A.M.C.): I agree with Dr. Barber that this condition falls into the so-called "fixed erythema" group, although I have never seen the exact counterpart of the condition presented by this patient. I recall some years ago reviewing this subject in the "Jadassohn Handbuch" and the "Nouvelle Pratique" and being rather overwhelmed by the large number of terms which have been applied to variants of this condition. By way of treatment, I would suggest a trial of light applications of solid carbon dioxide or carbon dioxide "slush". This would be rather tedious, but could be tested in a small area first. The slight local reaction produced has had a beneficial effect in similar cases in my experience.

I have had no experience of protein shock therapy in these cases.

THE PRESIDENT: Dr. Barber advised a trial of sulphanilamide. His suggestion is that these cases are streptococcal in origin.

### Angioid Streaks with Pseudoxanthoma Elasticum (Gronblad-Strandberg Syndrome).—

Major R. E. WRIGHT and W. FREUDENTHAL, M.D.

Male, aged 24, dark. Past and family history, nil important. Has one sister, not examined. Angioid streaks first observed 12.9.42 at routine examination Military Optical Centre by Majors Fergus and Gluck

Patient had no complaint. R.E.V. 6/18, L.E.V. 6/12. With glasses 6/6 each eye. Lenses and vitreous bodies clear. The discs and vessels are within normal limits, as also the foveæ and their immediate surroundings, although the macular areas are invaded by streaks. There is no pallor of the macular areas. The peripapillary regions are markedly affected. An irregular series of incomplete smoke-coloured rings with interspaces in parts paler, in parts darker, than the general eye grounds, form the hubs of a series of well-defined smoky-brown angioid streaks which radiate in all directions. Wider than the retinal vessels near the disc, they appear to taper to a finish about 4 D.D. out. The larger clefts are often flanked by pale borders, bounded in turn by a more smoky zone of eye ground. There are occasional pale spots throughout the fundi, and a fine powdered appearance most marked in mid-peripheral semicircles to the outer aspects of the macula. There are no hæmorrhages. Some of the streaks in the finely mottled mid-periphery are of capillary fineness and appear to end in the dark dots. (Coloured drawings of fundi were shown.)

Skin: Skin changes are only found in two symmetrical areas on the lower abdomen, at a distance of two inches to the right and left of the umbilicus. These two areas, four and three inches respectively in diameter, contain a great number of small cutaneous nodules or short streaks. The lesions can be seen or felt only with difficulty, but by stretching the skin they become more distinct and a whitish-yellow colour becomes

The differential diagnosis is between pemphigus vegetans and epidermolysis bullosa hereditaria. For the former we have the clinical appearance and the apparently spontaneous development, but in a case of this severity and duration one would expect more general disturbance, lesions of the mucous membranes and Nikolsky's sign. For epidermolysis bullosa hereditaria, the appearance of the condition so soon after birth and in the other twin and the absence of general disturbance seem to favour the diagnosis. But the fungating and condyloma-like lesions and the absence of the disease in the ascendants made us hesitate to pronounce the diagnosis.

To the two varieties of epidermolysis bullosa hereditaria, as classified first by Hallopeau, later by Siemens, namely (1) the dominant hereditary epidermolysis bullosa simplex; (2) the epidermolysis bullosa dystrophica of recessive inheritance, the French dermatologists Nicolas, Moutot and Charlot added a subvariety of the latter type, the *forme ulcéro-végétante d'épidermolyse bulleuse dystrophique*. They report a case of 3 children born of a healthy couple, who had an eruption consisting of bullæ which developed into slowly progressive, chronic, ulcerating and vegetating lesions. There was dystrophy of the nails and stenosis of the pharynx, following ulceration. They connect the case which, in respect of the skin lesions, the familial occurrence and the appearance soon after birth, much resembles ours, with epidermolysis bullosa dystrophica, because of its congenital, familial character, the bullous eruption and the dystrophy of the nails. Later nail lesions appeared and reports were received of similar eruptions in two cousins of the patients.

THE PRESIDENT: I confess I have never seen so severe a case of the hereditary type of epidermolysis bullosa. I have never seen one with fungations. The general condition of the child, considering the condition of the skin, is extraordinarily good.

#### Superficial Basal-cell Carcinoma.—F. S. AIREY, M.R.C.P.E.

A man, aged 43, shows a scarring lesion of the upper part of the left cheek, involving the lower eyelid. Ectropion is present. In the scar, and particularly at its margin, are raised portions which have the character of the spreading edge of a basal-cell carcinoma.

I first saw him at the Leicester Royal Infirmary in January 1943, when I was satisfied that the lesion was a superficial basal-cell carcinoma.

The history is that a "boil" appeared on the left cheek eight to nine years ago. A diagnosis of lupus vulgaris was made (not by a dermatologist) and ultraviolet irradiation (Kromayer) was given intermittently for some years. Ultimately the patient ceased attendance. He states there was improvement after this treatment but that recrudescence followed a bruise. Since then the lesion has received no treatment and has spread steadily.

The case is presented first because of the original diagnostic error which led to inappropriate treatment and allowed the lesion to spread unchecked, second because I believe the features of a superficial basal-cell carcinoma are here well illustrated, and finally to invite discussion as to the most suitable method of treatment, particularly with reference to the eyelid.

In other cases I have found it sufficient to curette the lesion and apply diathermic coagulation to the visible residues and active periphery. During the follow-up period some further attention may be required. There is sound scar in parts and I prefer some more discriminating method than X-ray or radium. Ultimately the help of the plastic surgeon is likely to be required for reconstruction of the lower eyelid, which offers its own special problems.

Should the case be passed over to the surgeon immediately? We know the growth is superficial and it should be possible to excise it completely and repair the defect with a free full-thickness skin graft. An alternative would be to destroy the growth first with diathermy, X-ray or radium and then to repair such defect as remains.

Dr. PROSSER THOMAS: I have recently had a case very like this one, a flat basal-cell carcinoma of the cheek with involvement of the lower eyelid and ectropion. He also, incidentally, had been treated for some years as lupus vulgaris. He has now been treated with Chaulin therapy by Dr. Smithers at St. Thomas's Hospital with a very good immediate result and has been referred to the plastic surgeon for reconstruction of the eyelid.

#### Pyogenic Granuloma of the Chin, Associated With and Dependent Upon a Dental Alveolar Abscess.—F. S. AIREY, M.R.C.P.E.

A woman, aged 43, was first seen at the Leicester Royal Infirmary in October 1942. She had a typical pyogenic granuloma overlying the symphysis mentis, 15 mm. in diameter and hemispherical in outline. It had been present for some months, bleeding and discharging pus from time to time.

xanthoma or scleroderma. The epidermis was loose and there was a feeling of thinning of the cutis, suggestive of some atrophy. There were lesions on the anterior axillary folds in which the epidermis was so redundant that it gave the impression of a soft mole or the cutaneous lesions of von Recklinghausen's disease. The skin was not dermatographic.

*Section of one of the early lesions.*—Some œdema of the cutis. Dense collection of mast cells, forming a band throughout the mid-cutis.

*Section of an older lesion.*—Similar dense collection of mast cells throughout the mid-cutis. The elastic tissue is deficient in this area.

Dr. PARKES WEBER: As to the first case I think it is one of urticaria pigmentosa in the adult of somewhat telangiectatic type. I suggest that in a graded series of cases at one end one would place the typical case of urticaria pigmentosa and at the other end one would place the much rarer typical telangiectasia macularis perstans.

### ? Fox-Fordyce Disease.—GEOFFREY DUCKWORTH, M.R.C.P.

Miss A. M., aged 56. Complained of intense irritation in the axillæ, around the nipples, and over the pubis for the past year.

*On examination.*—A lichenoid eruption is present—rather shiny papules, violaceous in the axillæ, and reddish on the areola of the right breast, with isolated ones on the left. No lesions have been seen on the pubis. Many of the papules show a central dimple.

Last menstrual period six months ago. The previous one, and the one before that were separated by several months and were profuse.

She has had a fractional dose of X-rays; stilbæstrol 1 mg. daily, for twelve days, and a lotion containing lead and tar, but with no relief of the irritation.

Suggestions for treatment will be welcomed.

Dr. ROXBURGH: I should think it is probably a case of Fox-Fordyce disease. The distribution of the lesions seems to fit in with that. The case I showed six months ago was much more pronounced and it improved very markedly with stilbæstrol, 1 mg. daily by mouth. When I reduced it to 1 mg. on alternate days she derived less benefit. At first the axillæ did not improve at all with X-rays, but only a few months ago I gave 400 r to the left axilla and subsequently to the right which did make a considerable difference, but by that time she had improved a great deal on stilbæstrol.

The stilbæstrol may start the menstrual periods again in Dr. Duckworth's patient. My patient was already having periods; she was much younger; 20 odd years of age.

THE PRESIDENT: It seemed to me that the papules in the axillæ were not typical of the Fox-Fordyce type. I am more in favour of lichen planus, although I confess that the localization is entirely against that diagnosis. Perhaps it is a little early to say she is not responding to stilbæstrol. To the best of my knowledge such cases always do respond; it is a very specific treatment. Has any member ever seen a case of Fox-Fordyce disease which has not responded to stilbæstrol?

Dr. ROXBURGH: I have not seen many cases of the disease.

THE PRESIDENT: I have seen two or three and they have all responded extremely well to stilbæstrol either by injection or by mouth.

### Case for Diagnosis. ? Epidermolysis Bullosa Hereditaria.—THERESE KINDLER, M.D. (for Dr. R. T. BRAIN).

N. H., a 3-year-old male child, has had a bullous eruption uninterruptedly since fourteen days after birth. A twin brother died from a similar affection. Parents and another baby well. No history of similar disease in the family; no consanguinity of the parents.

Bullæ of varied size appear on normal skin on any part of the surface, sometimes provoked by trauma, but not confined to exposed regions. Some bullæ heal without scarring, others—particularly on the face—develop into ulcerated and vegetating lesions with slow peripheral extension and no tendency towards healing. The moist areas of axilla and anus show papillomatous, condyloma-like excrescences. Mucous membranes are unaffected; nails and hair, normal. Nikolsky's sign not present. No irritation or general disturbance. No seasonal changes. No abnormality found in ear, nose, throat, chest or abdomen. Blood picture normal, except for anæmia. Wassermann and Kahn negative. No pyrexia, except a few insignificant rises.

Patient has been consecutively treated with blood transfusions, sulphanilamide and sulphathiazole *per os*, sulpharsphenamine injections and high doses of vitamins A and D, B, C, and P. Locally, gentian violet, triple dye, sulphathiazole powder, ung. hyd. oxid. flavum have been tried, also covering all the lesions with tulle gras and leaving them undisturbed. No treatment had any effect.

the neck, in the axillæ, and a short distance along the inner side of each upper arm. Just beyond the loose areas there is a zone giving the appearance suggestive of "peau d'orange", although the follicular orifices do not appear enlarged and there are no comedones.

On palpation the loose skin feels soft and thickened and can be moved freely over the underlying body as if no subcutaneous fat were present. There is definite absence of elasticity, and the skin does *not* spring back if an attempt is made to stretch it.

There is no noticeable pigmentary anomaly in other areas, nor any overextensibility of the joints.

This appears to be a typical case of dermatolysis, originally described by Alibert in 1832. The condition is rare, and though cases have been reported by various authors, the last case shown in this Section was that of Sequeira (*Proceedings*, 1916, 9, Sect. Derm., 84) which was associated with congenital morbus cordis and kyphosis.

It is hoped to investigate this case more fully and to report later.

Dr. F. PARKES WEBER: I think this is the most wonderful case of cutis laxa that I have seen. It is not, of course, cutis elastica, although in the literature cases of cutis elastica are mixed up with cases of cutis laxa. I think that there are cases half-way between cutis laxa and cutis elastica. What is needed is careful microscopical examination of clinically typical cases. The present case of cutis laxa is perhaps a mono-symptomatic incomplete form of the Ehlers-Danlos syndrome. Typical cases of the Ehlers-Danlos syndrome show fragility of the deep cutis better than any of the incomplete cases, but they often show the cutis laxa and the hyper-extensibility of the small joints very imperfectly.

Dr. W. FREUDENTHAL: Not many cases of this rare condition have been examined histologically and the reports differ a great deal. In some cases neurinomatous changes like those in von Recklinghausen's disease have been found.

Dr. PARKES WEBER: The cutis laxa in the present case is so excessive over the abdomen that it looks at first as if the patient were wearing a flesh-coloured garment. Here I agree it resembles the skin flounces and pendulous curtains of rare cases of von Recklinghausen's neurofibromatosis.

Dr. W. N. GOLDSMITH: I am interested in the somewhat "peau d'orange" appearance of the skin in the region of the breasts and the back of the neck. The skin between the pilosebaceous orifices is raised into fine firm ridges, leaving the orifices themselves relatively depressed. In several cases of Ehlers-Danlos syndrome, on the contrary, I have noticed the hair follicles, especially below the knees, to be prominent. The "peau d'orange" changes are not present in those areas where the skin is lax.

THE PRESIDENT: It would be interesting in years to come to see whether the symptoms just described by Dr. Goldsmith are really prodromal to the cutis laxa which is so obvious on the abdomen.

#### Folliculitis Decalvans (de Quinquad).—L. FORMAN, M.D.

Mr. F. W., labourer, aged 52.

Sixteen years' history of pustules commencing around chin and then involving limbs, armpits, pubic area and scalp.

He shows blepharitis, conjunctivitis, and crusted lesions on the face. Large areas on the forearms, thighs, and lower legs show absence of hair, but no obvious scarring or pustules. Similar area of alopecia without pustules over pubic area. Eyebrows scanty. Around scalp, extending as a band above the ears, completely smooth, hairless, slightly atrophic area, bordered by perifollicular pustules.

I showed this case because of the very considerable area of baldness of the scalp which had been produced by the staphylococcal folliculitis.

The amount of scarring of the bald scalp and limbs is surprisingly slight.

#### Case for Diagnosis. ? Sarcoid.—C. H. WHITTLE, M.D.

G. W., married woman, aged 51. History of one year's duration of itchy nodes or papules on the upper third and inner sides of thighs, and on the left wrist on its volar aspect. Climacteric symptoms are present, with hot flushes and amenorrhœa since one year ago, but the patient is otherwise well. Previous personal and family history, nothing of note.

The lesions consist of three plaques up to one inch in diameter on right thigh near groin and four smaller ones on the opposite thigh. Also an aggregation of papules on the front of left wrist. The papules which comprise the lesions are suggestive of lichen planus, especially on the wrist, in that they are bluish-red, flat-topped, angular in outline

I believed it to be caused by a median mental sinus draining a dental alveolar abscess, and this was confirmed by intra-oral X-ray examination.

All the teeth were removed and discharge from the granuloma ceased immediately. The growth itself was removed by the diathermic snare. Microscopic examination of the tissue confirmed the nature of the lesion.

[The patient was not presented but a colour photograph, dental X-ray film and sections were shown.]

I have myself seen about six such cases in the past three years. The underlying cause is not always appreciated, and I have known instances where these granulomata have been removed and have recurred because the existence of a sinus and the abscess which it drained was not suspected.



Intra-oral X-ray photograph showing dental alveolar abscess in the case of pyogenic granuloma.

All my cases have been over the symphysis mentis, the course no doubt having been determined by gravity. But I am informed that such sinuses may take an unlimited variety of routes and point at various places on the surface of the face.

I may add that the granulomata were seemingly adherent to the mandible, due to fibrosis and induration of the soft tissues.

I regret that I did not ask for an X-ray photograph of the track of the sinus employing a radio-opaque medium.

I have not seen this condition described as an entity in textbooks but have lately read an article on "cutaneous fistulas of dental origin", that deals with the subject (Wende, R. C., and Solomon, H. A., 1942. *Arch. Derm. Syph., Chicago*, 46, 665).

Dr. PARKES WEBER: What is really meant by granuloma pyogenicum? I had an idea it was one of the terms used for rare pedunculated strawberry-like growths sometimes observed growing from the fold at the root of the nails. There has been a great deal of literature on the subject, especially in France. They have been called, as far as I know, human "pseudo-botryomycoma", somewhat resembling lesions seen in cattle due to true *Botryomyces*. I suppose that the term granuloma pyogenicum might include any granulomatous lump caused by one of the pyogenic microbes.

Dr. DUCKWORTH: Median mental sinus was (I think) first described in this country by Hamilton Bailey. I published a case in 1940 (*Brit. J. Derm.*, 52, 57), which seems to be similar to this one.

Dr. AIREY: I refer to this condition as "granuloma pyogenicum" because the lesion, clinically and microscopically, is a granuloma. Since this granuloma is produced by pus and fails to recur when the pus is removed, it seems to me that the name is appropriate.

[February 18, 1943]

**Dermatolysis (Cutis Laxa).—J. E. M. WIGLEY, M.B.**

Mrs. K. F., aged 29. No children.

About two years' history. Skin of abdomen and middle area of back has become loose. No subjective symptoms. She has lost rather less than 1 stone in weight over this period but feels quite well and is able to do a full day's work. She appears a healthy woman and routine physical examination reveals no abnormality of any internal organs.

From about the level of the breasts to the upper ends of the thighs the skin over the abdomen and on the flanks appears to hang loosely, giving the impression of a loose cover of a chair or sofa, as if too big for the enclosed trunk. The whole of the loose area appears pinker than the surrounding skin. The same condition is seen on the sides of

When I saw her she presented numerous scars with gangrenous ulcers on the left breast and below the left scapula. No systemic disease was present and the Wassermann was negative.

The nature of her occupation renders access to chemicals easy.

**ADDENDUM.**—*Histological report* (Dr. Robb-Smith): The appearances are exactly comparable with those found in either a chemical or thermal burn and would probably support a diagnosis of dermatitis artefacta.

**THE PRESIDENT:** Have you tested the lesions with litmus? There is a proprietary alkaline and caustic cleaning agent which twice in my experience has been the cause of lesions such as these. The cases were in domestic servants, and, being labelled "Dangerous to the skin", it doubtless occurred to them that it would be useful for their purpose. Treatment in these cases is difficult without the aid of a psychiatrist.

**Sporotrichosis.**—CLARA M. WARREN, M.R.C.S., L.R.C.P.

Mrs. E. S., aged 59. Three weeks ago, she was in such a condition that it was necessary to proceed at once with treatment, without waiting for the results of the culture which I made.

The history is that three months ago, while pruning rose-trees, she pricked her arm on a thorn. Within a week a large, purple-coloured swelling had developed. Pink pus discharged very freely through several openings in the centre and at the periphery of the abscess. She had two feverish attacks and these were followed by an increase in the swelling and in the discharge of pus. She was admitted to hospital for surgical treatment, owing to development of lymphangitis, œdema and adenitis of the arm. She was given sulphapyridine, with some amelioration of the local condition. The abscess, however, had not healed when she was discharged.

When I examined her there was a raised soft nodule, three inches across, on the extensor surface of the left forearm. It was deep brownish-purple in colour, and showed irregularly placed small ulcers in the centre and near the margin of the swelling. The edges of the ulcers were undermined, and pus could be expressed from one ulcer to another, under bridges of soft skin. The skin over the pockets, and between the ulcers, was raised, and had a "quilted" appearance.

No granulation tissue could be seen. Where healing had occurred, the scar was soft and easily damaged. Residual thickening of the regional lymphatics could be felt, leading to the epitrochlear gland.

Scrapings from the undersurface of the skin over a pocket of pus showed fine mycelia, but culture, taken two days after the treatment was begun, did not grow mycelia or spores.

To-day, three weeks after specific treatment for sporotrichosis was started, the "quilted" appearance is still present, and subcutaneous pockets of pus can still be seen. Treatment, which is being continued, has consisted of potassium iodide by mouth, gr. xv three times daily, local ultraviolet light to the abscess on alternate days, and twice daily applications of 5% sulphathiazole in saline.

**THE PRESIDENT:** Sporotrichosis is very rare in this country and perhaps our Trans-Atlantic colleagues would add their comments.

Lieut. T. W. MURRELL, Jr. (U.S.A.M.C.): I have been fortunate enough to see four cases all occurring in soldiers during manœuvres in the southern part of the United States. The men just picked up an accidental scratch from a thorn and most of them had no idea how they got it. Shortly afterwards they noticed a simple infection on the arm which failed to clear up. The lesions soon developed into large single abscesses and the characteristic nodules appeared on the arm. I think one would rarely be able to make a diagnosis of sporotrichosis without seeing the little nodules along the lymphatic channels of the arm; these often do not appear where one would imagine the lymphatics to be.

Before we saw the cases all kinds of applications had been made to the original lesions, and we assumed that it would be very difficult to isolate the organism from one of the abscesses. We excised one of the nodules in all cases, macerated it in normal saline, and put the material on a suitable media, and eventually a diagnosis was made. In to-day's case sinuses had been present; I have never seen a case in which sinuses developed.

The cases are resistant to treatment; we gave iodides by mouth, iodine solution to the single lesions and in one case X-rays. I think the method of cutting the nodules and macerating them in normal saline may be of help in making a diagnosis. The treatment was fairly successful but rather slow.

In the absence of nodules up the arm and, furthermore, according to the description of the original lesion, I would hesitate to call this case sporotrichosis.



and occur in the usual distribution, but the thigh lesions are infiltrated and the plaques have sharply defined raised margins, with a tendency to flatten in the centres. There are no lesions to be seen on the mucosæ.

Mantoux reaction positive. 0.1 c.c. of 1:1,000 human (O.T.) gave 2 cm. wheal and flare. 0.1 c.c. of 1:1,000 bovine (O.T.) gave 2.5 cm. wheal and flare. Control negative.

X-ray of chest: No evidence of tubercle.

A diagnosis of lichen planus hypertrophicus was made tentatively and a biopsy done to confirm this and to exclude amyloidosis, but it showed a tuberculoid structure, suggestive of sarcoid, and no amyloid changes. (Section shown.)

A Wassermann test is being done.

This case presents some difficulty in diagnosis. If it is similar to other cases which I have seen I should expect these lesions to resolve either spontaneously or with some sedative treatment leaving nothing but a little superficial scarring and pigmentation.

Dr. PARKES WEBER: A superficial inspection brings two other diseases to my mind: a kind of lupus disseminatus, and what we seldom see nowadays, Kaposi's so-called multiple hemorrhagic sarcoma, but the microscopical examination should settle the question.

ADDENDUM (C. H. W.).—The Wassermann test is positive. The lesions have responded to antispecific measures.

#### ? Parapsoriasis.—C. H. WHITTLE, M.D.

E. T., a man, aged 30. Nine months ago an eruption started on the left calf and spread over the legs and trunk. It never cleared completely but there was a recrudescence four weeks ago. The original diagnosis had been pityriasis rosea.

The lesions consist of bluish-red slightly infiltrated plaques as much as one inch in diameter, rather irregularly distributed over the lower abdomen, back and thighs. There was slight scaling when first seen and the scales had their free margins directed towards the centre of the lesion in the fashion of pityriasis rosea. The reaction to scratching was not characteristic of psoriasis. Lesions have recently appeared also on the upper arms, extensor surface. Some of the lesions appear to have a purpuric element.

There was no glandular enlargement and no history of venereal disease, nor of drug taking.

Wassermann negative. Hess test (capillary resistance) negative and normal.

Biopsy: Slight œdema of prickle cell layer and parakeratosis, leucocytic infiltration of subpapillary layer of corium, fairly dense, lengthening of interpapillary processes, no sign of extravasation of red cells.

The diagnosis that first occurred to me was pityriasis rosea, but the eruption has been present for nine months.

A likely diagnosis then was parapsoriasis because some of these cases do start like pityriasis rosea. I may have missed the purpuric element at first, but it is there now. There is not a great deal of scaling. Biopsy showed a reaction rather like a mild psoriasis with œdema of the prickle cell layer and leucocytic infiltration. There was no evidence of extravasation of red cells.

Dr. PARKES WEBER: Is lichen ruber planus considered to be excluded by the microscopical examination?

Dr. C. H. WHITTLE: No: but I do not think it is lichen planus.

Dr. PROSSER THOMAS: This eruption suggests a condition described in America a few years ago by Sulzberger and Garbe (*Arch. Derm. & Syph., Chicago*, 1937, 36, 247), which they named "A distinctive exudative discoid and lichenoid chronic dermatosis".

ADDENDUM (C. H. W.).—Another biopsy has been done of a very early lesion, which shows well-marked extravasation of red cells into some of the papillæ and normal epidermis.

#### ? Artefact.—A. MURRAY STUART, F.R.C.S.

Miss L. T., aged 37, a chemist's assistant, gave a history of having been in and out of hospital since 1938 suffering from metrorrhagia (due to diffuse adenomyosis and atrophy of the endometrium) and culminating in subtotal hysterectomy in 1941. About this time her fiancé was reported missing.

In 1942 she began to develop a series of lesions on her left hand, buttocks, perineum, nape of neck, left knee and foot, left scapula and left breast. She is right-handed.

Her doctor reports that the lesions have all commenced in the same way with an erythematous patch which rapidly turns black and sloughs and that no treatment has had any permanent effect.



Dr. WARREN: The patient told me she had nodules up her arm before I saw her. When I saw her there was palpable thickening where the nodules on the front of the arm, as described by the patient, had evidently been. The thickening gradually disappeared within a fortnight of the potassium iodide being given.

**Pityriasis Rubra Pilaris of Late Onset.**—E. W. PROSSER THOMAS, M.D.

T. W., a man aged 71. Past and present general health good. No previous skin disease. Eruption began about one year ago as diffuse fissuring hyperkeratosis of palms and soles which was followed by spiky follicular hyperkeratosis of backs of fingers soon generalizing to produce well-marked nutmeg-grater effect. Eruption has now passed into more or less universal branny desquamation with yellowish colour, though grouped blackish horny cones are still to be seen on the backs of the fingers.

In this case the onset of the eruption is late in life—at the age of 70. Pityriasis rubra pilaris usually occurs in much younger persons, at any rate within the first half of life. I have the impression that this disease may be commoner in America than in this country; there it is definitely classified among vitamin A deficiency diseases. In a recent paper O'Leary, for instance, states that vitamin A is curative in it (*Arch. Derm. & Syph., Chicago*, 1942, 46, 628). I have been giving this patient vitamin A, 12,000 units daily by mouth for nine months. The dosage may have been too small. It is difficult to say whether or not the disease is pursuing its natural course, as it is so rarely seen here.

Dr. C. H. WHITTLE: We have not had more than one or two cases in our practice. I can only remember one which was under observation when the work on vitamin A came out, and we gave her about 100,000 units of vitamin A per day for several weeks without the slightest change. I should like to hear what our American colleagues have to say because the accounts in the American literature were encouraging.

Major EMERSON GILLESPIE (U.S.A.M.C.): I think we can say that this disease is rare in America. I have had a case recently in which we used large doses, 200,000 units a day, and I did not notice a marked improvement. I am sure my colleagues would agree that the reports may be a little more optimistic than anything we have seen personally.

Dr. L. FORMAN: I have been watching a lady who has had repeated attacks of pityriasis rubra pilaris and who generalizes as this man has done. She had vitamin A injections, so that there was no doubt that she did absorb it, and there was no apparent effect at all on her disease.

Another interesting feature of the case was that before each attack—and I have seen her in three now—she has a very definite weakness of her arms. She says she knows when she is going to have an attack because it is difficult to hold her arms up. That weakness persists during the height of the illness and when she is better—we have been treating her with T.A.B. intravenously—the weakness disappears. I wonder whether others have noticed the association of muscular weakness.

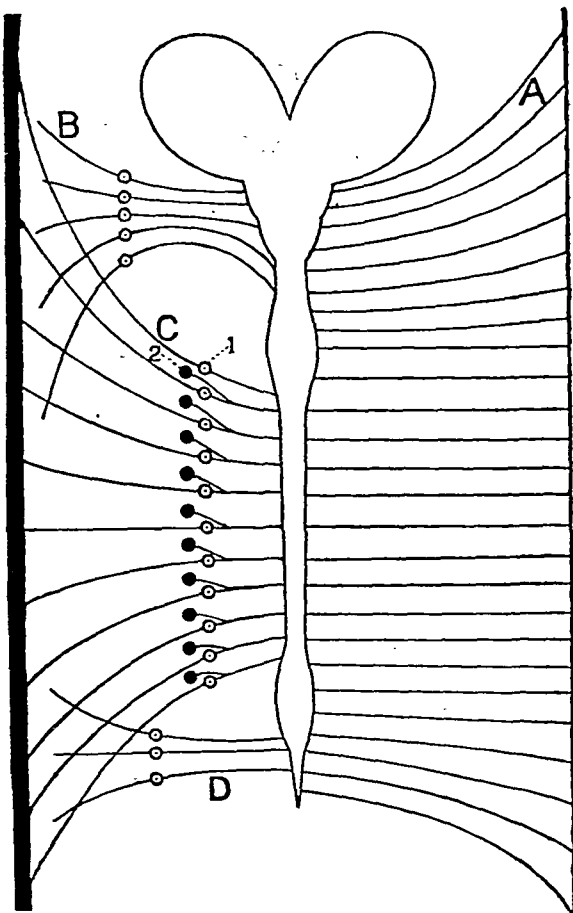
The broad localization of function in the spinal cord is clearly depicted in fig. 3. The thoraco-lumbar sympathetic outflow from the lateral horn cell lies between the two enlargements for the limbs. The first three somatic cervical nerves are devoted to movements of the head and neck and subserve posture in particular: the 4th cervical nerve sends most of its fibres into the diaphragm and is devoted to respiration. The lower four cervical nerves and the 1st thoracic, by their anterior primary divisions, form the brachial plexus; the lower four lumbar nerves and first three sacral form the lumbo-sacral plexus for the lower limb. At the two ends of the central nervous system are found two special arrangements designed in particular to control the integrity and efficiency of the orifices, sphincters and glands at the cranial and caudal ends of the body. These are the bulbo-cranial parasympathetic outflow anteriorly in the 3rd, 7th,

FIG. 3.—T. R. Elliott's diagram of the nerves efferent from the central nervous system in the mammal.

A, the non-ganglionated ordinary motor nerves to striped muscle, which are distributed segmentally. On the left side these are omitted for simplicity, and only the autonomic or ganglionated visceral nerves to plain muscle are indicated. Of these, B is the cranio-cervical outflow in the vagus, &c.; C, the thoraco-lumbar or sympathetic proper; D, the sacral outflow, or pelvic visceral nerve to the bladder and colon. All these subdivisions contain both motor and inhibitory nerves.

C1 is the sympathetic ganglion-cell; C2, the paraganglion-cell secreting adrenaline, the chief mass of these being concentrated to form the medulla of the adrenal gland, though a few, even in adult life, may be found elsewhere in relation to the various sympathetic ganglia. The black rectangle innervated by the nerves from the cells C1 represents the mass of plain muscle which is also stimulated by adrenaline, that is by the secretion of C2.

Afferent sensory nerves and their posterior root ganglia are all omitted from the diagram. Their course from the viscera is not clearly known. (From *Brain*, 1913, 35, 313.)



9th and 10th cranial nerves, and the sacral parasympathetic outflow posteriorly from the 2nd, 3rd and 4th sacral nerves.

#### INNERVATION OF THE SKIN OF THE LIMBS

The first indication of the upper limb bud appears during the third week of embryonic life as a slight swelling in the lower cervical region. During the fourth week, the base of the limb bud lies at the level of the lower four cervical and 1st thoracic vertebrae. In the fifth week the core of the skeleton and pre-muscle tissue appear, as hand, wrist, elbow and shoulder become more clearly marked. The nerves of the brachial plexus push their way into the pre-muscle sheath surrounding the cartilaginous core. By the end of the sixth week most of the muscles of the arm and forearm are easily recognized, the muscles of the hand are still forming and most of the branches of the brachial plexus found in the adult are present. The development of the lower limb follows the same pattern, the stages being a few days later than in the upper limb, and the

posterior root ganglion. The two roots join to form the common or mixed nerve trunk, which soon divides into a posterior primary division to supply the skin and musculature of the back, and an anterior primary division running ventrally in the costal parietes to supply the skin and musculature of this region. This anterior primary division gives off a lateral branch which emerges near the mid-axillary line and gives off two branches which run dorsally and ventrally to supply the skin of the flank. The anterior primary division ends in a terminal branch which supplies the skin and muscle of the ventral wall. Thus the trunk of the embryo (fig. 2) shows three longitudinal bands, supplied respectively by posterior primary division, lateral branch of the anterior primary division and terminal branch of the anterior primary division. Two other rami are given off from the mixed segmental nerve, the white ramus communicans which supplies the involuntary muscle of the blood-vessels, arrectores pilorum and sweat glands by way of the sympathetic system and the meningeal branch which runs back to supply



FIG. 2.—Human embryo of about 5½ weeks showing the two limb buds on the territory of the flank, supplied by the lateral branches of the anterior primary division of the segmental nerves. (No. 801 in Professor J. P. Hill's collection at University College, London.)

the structures in the spinal canal, including the spinal cord, its vessels and its meninges. This segmental neurotome, so clearly demarcated in the thoracic region, is disrupted in the cervical, lumbar and sacral regions by the development of the two large plexuses for the limbs, a superior cervico-brachial plexus and an inferior lumbo-sacral plexus. The limb plexuses are formed entirely of the anterior primary divisions of the nerves; no posterior primary divisions participate. It is still a matter for discussion as to whether the limb plexus consists of the lateral branches of the anterior primary division or of the terminal branches of the anterior primary division or of both. In the diagram (fig. 1) the skin of the limb and the musculature are represented as supplied by the lateral branch only.

The thoraco-lumbar outflow of white rami communicantes for the sympathetic efferents to blood-vessels, sweat glands and arrectores pilorum is localized in the spinal cord over that region which extends from the 1st dorsal to the 3rd lumbar segment. The efferent nerves to the splanchnotomes have, so to speak, been telescoped to lie within the portion of the spinal cord which extends from the upper limb enlargement to the lower limb enlargement.

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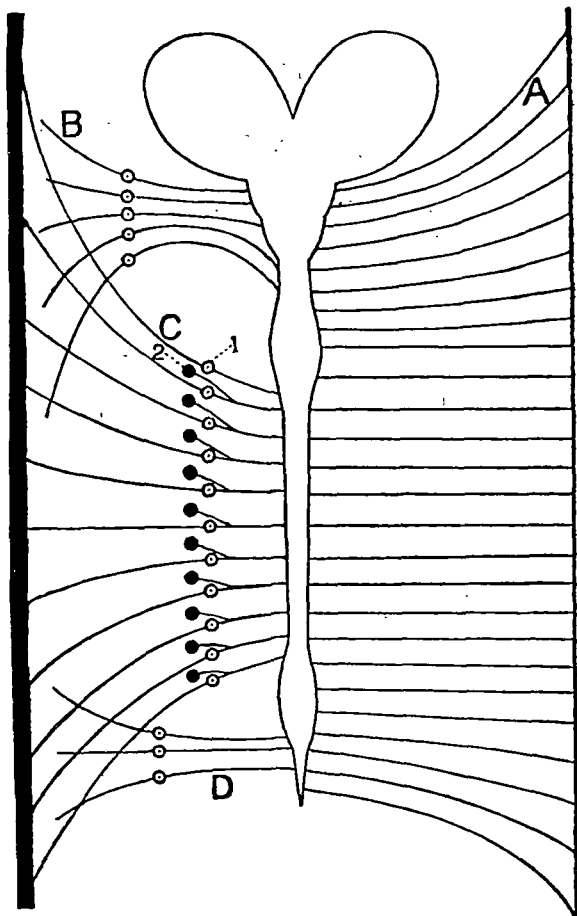


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base of the limb lying at the level of the lower two lumbar and upper three sacral vertebræ. As the nerves of the anterior primary division grow into the upper limb bud forming the plexus, they tend to re-sort themselves into a posterior group for the extensor aspect of the limb and an anterior group for the flexor aspect. In the upper limb this resorting gives rise to the posterior cord for the extensor compartment and the lateral and medial cords of the plexus for the flexor compartment.

Although the brachial plexus consists essentially of the five anterior primary divisions of the lower four cervical and 1st thoracic nerve, yet the segmental character of the cutaneous nerves is altered in two ways. In the first place the dermatomes are not symmetrical about the central axis of the limb, for the more cranial nerve reaches the surface and "runs out" before the more caudal. Secondly, the central nerve of the plexus

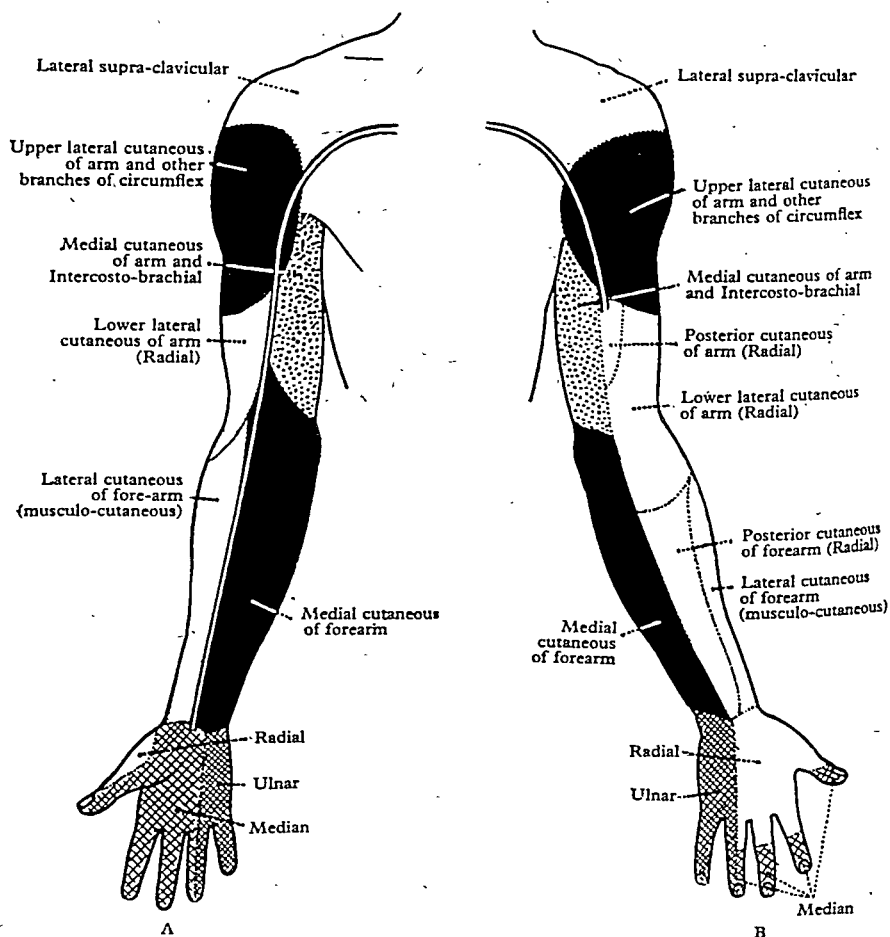


FIG. 4 (A and B).—Diagrams of the cutaneous nerve distribution in (A) the flexor, and (B) the extensor surfaces of the upper limb, with the ventral and dorsal axial lines along which the 7th cervical nerve fails to reach the surface, shown as two narrow white lines. (Modified from Paterson's diagram in Cunningham's Textbook of Anatomy.)

only appears on the surface towards the periphery of the limb. In the upper limb C.5 runs out on the preaxial border but T.1 continues down the postaxial border to the end of the little finger, and the central nerve C.7 does not appear in the arm but is reserved for the skin of the thumb (fig. 4, A and B).

As far back as 1857 Sir John Goodsir called attention to the fact that the higher or preaxial nerves in the plexus did not run as far into the limb as the lower or postaxial nerves. In 1886 W. P. Herringham of Guy's Hospital, as a result of detailed dissections of the brachial plexus, enunciated certain laws for the innervation of the skin. He maintained that the innervation of the skin of the limb was fundamentally segmental, but the skin was stretched over the growing limb bud like a sheet of indiarubber, so

that the skin of the limb contained not only five dermatomes (C.5 to T.1) but also an area at the preaxial border borrowed from the neighbouring 3rd and 4th cervical dermatomes in the descending supraclavicular nerves, and also an area at the postaxial border borrowed from the neighbouring 2nd dorsal dermatome in the intercosto-humeral (intercosto-brachial) nerve (fig. 4, A and B). In the case of the lower limb the borrowing from neighbouring dermatomes is of necessity limited to the preaxial dermatomes, T.12, L.1, L.2, L.3, for no borrowing could take place postaxially, as the dermatome of S.4 is limited to the perinæum around the anus. The lateral branch of the 12th thoracic or subcostal nerve thus supplies the skin of the buttock from the crest of the ilium laterally to the great trochanter—an area associated with referred pain in basal pleurisy (fig. 5, A and B).

Herringham enunciated two laws which may be stated as follows: (a) "Of two spots

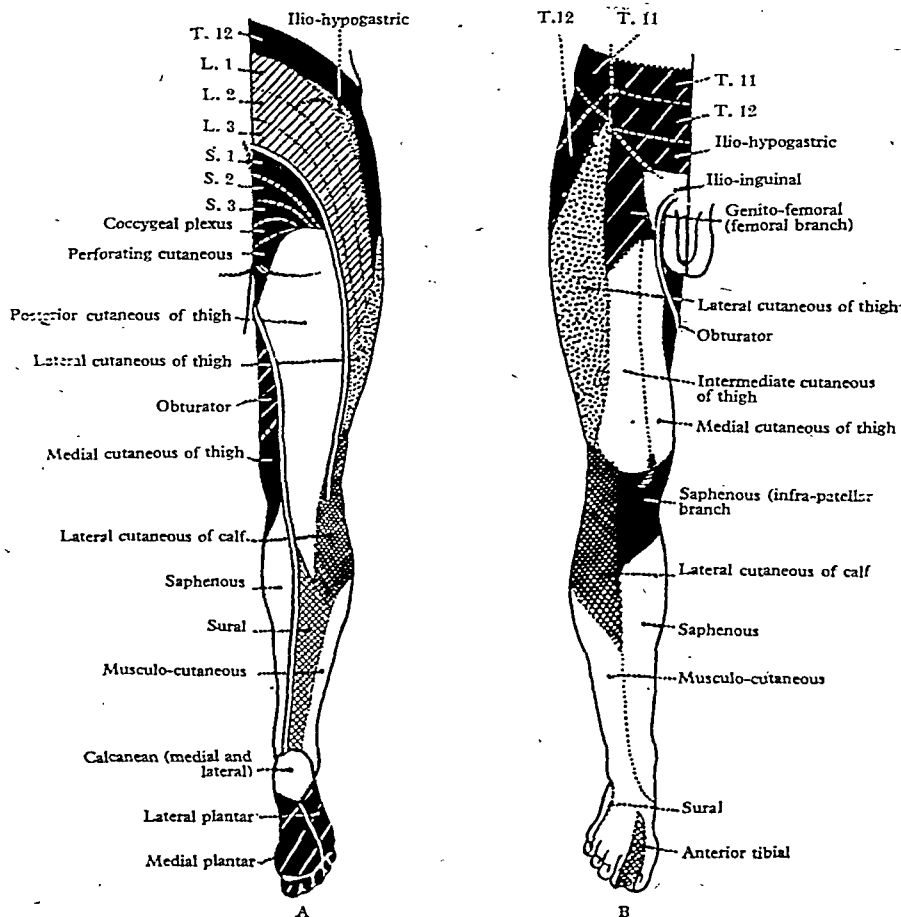


FIG. 5 (A and B).—Diagrams of the cutaneous nerve distribution in (A) the flexor and (B) the extensor surfaces of the lower limb, with the ventral axial line along which the 5th lumbar nerve fails to reach the surface and the dorsal axial line along which the 4th and 5th lumbar nerves are missing, shown as two narrow white lines. (Modified from Paterson's diagram in Cunningham's Textbook of Anatomy.)

on the skin of the limb, that nearer the preaxial border tends to be supplied by the higher nerve." (b) "Of two spots on the preaxial border, the lower tends to be supplied by the lower nerve. Of two spots on the postaxial border, the higher tends to be supplied by the lower nerve" (figs. 4 and 5).

During the period from 1865 to 1900 the cutaneous supply of the peripheral nerves was intensively studied by means of dissection on the dead (Krause, Herringham, Paterson), experiments on living animals (Sherrington), clinical observations on diseased human beings followed by careful post-mortem examination (Head and Mackenzie), and clinical observations followed by careful examination at operation (Thorburn, Ross, Dana, Starr, Kocher and Cushing). At the same time the sensations of heat, cold, pain and touch were



being analysed by von Frey and many others, nerve endings were studied histologically by Meissner, Ruffini, Dogiel, Retzius, Golgi and the sympathetic system gradually sorted out by Gaskell, Langley, Anderson and Dickinson. In this period Sherrington's earlier experimental work was, and still is, the most provocative of thought on the peripheral nervous system. He started the anatomical analysis of the prefixed and postfixed plexus, demonstrating that the segmental nerves were of greater morphological significance than the vertebræ and ribs which had been so actively pursued by Oken and Owen. He analysed the actual nerve fibres in terms of diameters ranging from  $1.5\mu$  to  $20\mu$  and associated size with function. He introduced the clear conception of the proprioceptive system, with sensory nerve endings in muscle, tendon and joint for the maintenance of posture. He first described the ventral and dorsal axial lines on the upper and lower limbs of the monkey.

#### VENTRAL AND DORSAL AXIAL LINES

By section of a single sensory posterior nerve root, Sherrington showed that there was diminution of sensation but never complete anaesthesia in the corresponding cutaneous area or dermatome. By sectioning the posterior roots, cranial and caudal of a particular nerve root, he showed that there was both a cranial and a caudal overlap of the dermatomes. Head and Mackenzie were of the opinion that the overlap in Man is not so extensive as in monkeys. In the limbs of monkeys Sherrington found a strange departure from the zonal system of the trunk. There is a hiatus in the numerical sequence of the nerves explicable on the ground that the central nerve of the plexus, which fails to reach the surface on the dorsal and ventral surfaces, is replaced by cutaneous branches from neighbouring nerves. This hiatus is the axial line. In the upper limb in Man the ventral axial line, due to the absence of C.7, runs from the mid line at the level of the sternal angle and 2nd costal cartilage across the chest and down the front of the arm and forearm to the wrist. The dorsal axial line runs from the 2nd dorsal spine across the scapular region to the insertion of the deltoid. In the lower limb the ventral axial line, due to the absence of L.5, runs from the root of the penis, along the medial side of the thigh, and along the back of the leg to the heel. The dorsal axial line runs from the 4th lumbar spine to the dimple over the posterior superior iliac spine and across the buttock and thigh to the head of the fibula. The hiatus on this dorsal axial line is due to the absence of L.4 and L.5. These ventral and dorsal axial lines are of the greatest interest in tracing the effects of injury to the nerves, in tracing the involvement of the posterior root ganglion in herpes or tabes, in analysing referred pain from a viscus, and in localizing lesions of the spinal cord.

#### THE SKIN OF THE FLEXOR AND EXTENSOR SURFACES OF THE LIMBS

From the early embryonic stages there are marked and persistent differences between the ventral flexor and dorsal extensor surfaces of the limb. In the first place the flexor skin differs from the extensor in texture, distribution of hair and grease glands, sweat glands and nerve endings such as the spots for heat, cold, pain and tactile discrimination. The former is afflicted with moist eczematous rashes, the latter with dry conditions simulating psoriasis. All five nerves of the brachial plexus supply the ventral skin, from C.5 preaxially to T.1 postaxially, but the extensor skin is supplied only by the lower four cervical nerves. No cutaneous fibres of T.1 reach the posterior cord or radial nerve, for they are all postaxially placed in the flexor compartment, in the medial cutaneous of the arm and forearm and the palmar and dorsal branches of the ulnar nerve.

Similarly the relatively coarse dry skin of the extensor aspect of the lower limb, on the buttock, front of thigh, front of leg differs from the moist hypersensitive skin of the groin, saddle, back of knee, calf and sole. The most postaxial nerve of the plexus S.3 appears in the flexor skin, postaxially placed, mainly in the posterior cutaneous or small sciatic nerve of the thigh—an area of skin peculiarly associated with referred pain in the urinary, genital, and ano-rectal structures developed from the embryonic cloaca.

#### INNERVATION OF THE LIMB MUSCLES

Certain generalizations by Herringham on the nerve supply of the muscles of the limbs are now generally accepted. The first states that no limb-muscle receives its nerve supply from posterior primary divisions of the segmental nerve. The second states that the dorsal extensor and the ventral flexor strata of muscles are always supplied by the corresponding dorsal and ventral branches of the anterior primary division of the segmental nerves concerned. Thirdly, the ventral stratum is more extensive than the dorsal stratum and the ventral nerves are more numerous, the additional nerve lying postaxially in the ventral compartment.

Limb			Ventral flexor	Dorsal extensor
Upper	...	...	C.5, 6, 7, 8, T.1	C.5, 6, 7, 8
Lower	...	...	L.2, 3, 4, 5, S.1, 2, 3	L.2, 3, 4, 5, S.1, 2

According to this view all the motor fibres of the 1st thoracic nerve lie in the flexor compartment near the postaxial border, i.e. in the ulnar nerve. There are no fibres of the 1st thoracic nerve in the posterior cord or radial nerve. Similarly in the lower limb, the fibres of the 3rd sacral nerve never appear in an extensor compartment but lie in the flexor compartment, near the postaxial border, in the nerve to the long head of the biceps and possibly in the nerve to the obturator internus. Although the fundamental pattern of the upper limb and lower limb involves five segmental anterior primary divisions, the cutaneous nerve pattern in Man and most mammals has involved borrowing from the neighbouring dermatomes. In the upper limb of Man this borrowing is limited to the cutaneous area of the descending supraclavicular nerves preaxially and to the intercosto-humeral nerve postaxially. No borrowing of neighbouring myotomes has taken place so that no muscle of the upper limb ever receives fibres from the 4th cervical or the 2nd thoracic nerve, except in the rare cases of preflexion or postflexion of the plexus respectively. In the lower limb of Man, on account of the great development of the muscles of the buttock and thigh, the plexus is not limited to the fundamental pattern of five nerves, the two lowest lumbar and the upper three sacral. For the cutaneous nerve supply there is extensive borrowing from the preaxial dermatomes, including the 12th thoracic and first three lumbar nerves. Further, in the lower limb, as distinct from the upper limb, there is extensive borrowing from the neighbouring preaxial myotomes so that motor fibres of the 2nd and 3rd lumbar nerves are prominent in the femoral nerve to the extensors of the knee and in the obturator nerve to the adductors of the leg.

As for the cutaneous nerves so for the motor nerves the more preaxial terminate sooner in the limb than the postaxial nerves. As for the skin areas so for the muscles; the more preaxial muscle is supplied by a higher nerve than a more postaxial. Herringham maintained that the most central nerve of the plexus runs furthest into the limb, so that C.7 runs down to the muscles of the ball of the thumb and L.5 runs down to the muscles of the ball of the foot. This is complicated, however, by the fact that the most postaxial nerve in the upper limb (T.1) runs down to the short muscles of the little finger in the ulnar nerve, but the most postaxial nerve in the lower limb (S.3) does not run down to the short muscles of the little toe, but runs out in the biceps femoris. Sherrington called attention to this when he stated that "the most posterior segment which contributes to the limb musculature contributes to the extreme apex and the extreme postaxial border of the forearm or leg, but not to the upper arm, so that the hindmost muscular ray is one with a break in its middle portion". It is suggested that the absence of any muscles supplied by the ulnar nerve in the arm, as distinct from the forearm, is due to the suppression in Man of those muscles of the axillary arch, traces of which are often seen in the dissecting room, particularly the dorso-epitrochlearis muscle.

#### THE SMALL MUSCLES OF THE HAND AND THE ULNAR NERVE

Most textbooks of anatomy at the end of the last century described those muscles of the ball of the thumb lying lateral to the tendon of the flexor longus pollicis as receiving their nerve supply from the median nerve, viz. the abductor brevis, the superficial head of the flexor brevis, and the opponens pollicis. The deep head of the flexor brevis, or *musculus primus intervarialis* of Henle, lying medial to the tendon of the flexor longus pollicis, was held to be supplied by the ulnar nerve, in common with both heads of the adductor pollicis and all the interossei. The recent survey by Hignett has focused attention on the extent to which some of the muscles of the ball of the thumb may have a dual supply, both from the median and the ulnar nerves. In view of the importance of the thumb as the dominant digit of the prehensile hand, the duality and variation of nerve supply is of the greatest importance from the point of view of the loss of function in industrial injuries to the hand. There is, however, another change which has gradually crept into the textbooks. Whereas the older textbooks placed the motor fibres of T.1 in the ulnar nerve only, since 1914 many textbooks have also placed fibres of T.1 in the median nerve. Some have gone even further, and maintained that the intrinsic muscles of the hand and thumb are all totally and even exclusively supplied by fibres of T.1. Inquiries among the older anatomists, surgeons and physicians have failed to uncover the origin of this change. After much searching in the literature at the end of the 19th and the beginning of this century, it appears that the change is ascribable to Kocher of Bern, who, in 1895, before radiographic examination became widespread, published his monumental paper on fracture of the spine and associated effects on the physiology of the spinal cord. In addition to analysing the cutaneous distributions of the lesions, Kocher published two diagrams of the brachial and lumbosacral plexuses. These diagrams were so simple and attractive that they spread to surgical, neurological and anatomical textbooks rapidly. The diagram of the brachial plexus depicts one-half of the fibres of T.1 running to the median nerve and one-half to the ulnar nerve. These fibres are together described as supplying all the small muscles of the hand

and fingers. The ulnar nerve is shown as containing fibres of T.1 only, C.8 being absent. This diagram of the brachial plexus was probably brought to Edinburgh by Sir Harold Stiles and gradually infiltrated current publications.

In 1925 Wingate Todd and his co-workers measured the cross-sectional area of the nerve roots in the brachial and lumbosacral plexuses of 31 dissecting-room cadavers. He discussed the results of previous observers such as Kolliker, Stilling, Ingbert and Wood Jones. The areas of the nerve roots are as follows, with no significant differences on the left or right side:

Brachial plexus			Lumbosacral plexus		
	Left	Right		Left	Right
C.5 ...	4.07	4.15	L.2 ...	5.78	5.90
C.6 ...	7.21	7.99	L.3 ...	7.58	8.42
C.7 ...	11.76	12.65	L.4 ...	8.90	10.10
C.8 ...	10.6	9.96	L.5 ...	10.50	11.76
T.1 ...	7.06	0.71	S.1 ...	12.36	11.63
			S.2 ...	7.12	6.60
			S.3 ...	2.56	2.43

It is evident that the central nerve of the brachial plexus, C.7, is the largest and this fits in well with Herringham's conception of the plexus and with Sherrington's conception of the ventral and dorsal axial lines. In the lower limb there is little to choose between L.5 and S.1, but the latter is slightly larger, although the central nerve of the plexus is L.5 and this is also the nerve which is missing on the ventral and dorsal axial lines. On the other hand S.1 is the central nerve of the primitive type of plexus of five nerves ranging from L.4 to S.3.

The method of Todd was applied to sagittal sections of the brachial plexus of an eleven weeks' human embryo. The area of T.1 is only one half the area of C.8. This indicates that it is very unlikely that T.1 is responsible for the supply of the muscles of the postaxial border of the fore-limb, flexor carpi ulnaris, the ulnar head of flexor digitorum profundus, the intrinsic muscles of the hand and of the thumb as well. Sherrington pointed out that the motor fibres in the spinal nerve trunk with a diameter of  $20\mu$  are larger than any of the other fibres which range from  $18\mu$  down to  $1\mu$  in descending order for touch, pain, heat, cold and sympathetic efferents.

For the following reasons it is difficult to accept the view that fibres of T.1 supply the mass of fibres to the intrinsic muscles of the hand in the ulnar nerve and also to the three preaxial muscles of the ball of the thumb in the median nerve:

(1) The measurements of the diameter of the 1st thoracic nerve in the adult and embryo show that the root of T.1 is too small to supply the large motor nerve fibres to all the muscles of the hand, including the thumb.

(2) The motor fibres of T.1 are essentially and fundamentally postaxially placed in the plexus and are limited to the flexor compartment.

(3) Lesions of the cord in cases of fractured spine as analysed by Kocher are not a safe index for detailed localization at the periphery as the vascular lesion extends up and down the cord; the softening of the cord as a result of thrombosis in the spinal veins produces signs and symptoms in several segments.

(4) There is at present no clear proof that localization in the cord is confined to such segments as are demarcated by the origin of the rootlets of the posterior sensory and anterior motor nerve roots.

(5) The variation in the length of the so-called segments of the cord suggests that there may be as much overlapping in the cord as there is at the periphery in the sensory dermatomes. These segments vary from about 12 mm. in the cervical region to 24 mm. in the thoracic region and 10 mm. in the lumbar region.

(6) The existing notions of the morphology of the plexus, of C.7 as the central nerve extending furthest into the limb, of C.7 giving rise to the hiatus of the ventral and dorsal axial lines, make it unlikely that the most postaxial nerve, T.1, would supply the muscles of the most preaxial digit in the hand.

(7) Most limb muscles are supplied by at least two nerve segments. Unisegmental or monomeric muscles are so rare that it is unlikely that all the muscles of the fingers and thumb, the last to differentiate in the fifth and sixth week of embryonic life, would be supplied by one nerve segment only.

(8) Romanes has shown in the human embryo of fourteen weeks that the postero-lateral and post postero-lateral columns of the ventral horn cells supplying motor fibres to the muscles of the hand extend over the 8th cervical and 1st thoracic segments of the cord.

#### MUSCLES WITH A DOUBLE NERVE SUPPLY

Our knowledge of the action of muscles has grown by small accretions from the time of Borelli, Steno, Winslow, John Hunter, Ed. and W. Weber, Duchenne and Charles Beever to the present day. Sherrington, by his studies of reflex action, reciprocal innervation and decerebrate rigidity has profoundly influenced our conceptions. A point of major anatomical and clinical interest throughout the history of muscle action has been

the number of spinal segments and the number of nerves supplying a particular muscle. The terms unisegmental or monomeric and multi-segmental or polymeric have been employed. The pectoralis major consisting of clavicular and sternal heads of origin receives its nerve supply from the lateral cord (C.5, 6, 7) and the medial cord (C.8, T.1) of the brachial plexus, so involving five segments of the spinal cord. At the other extreme there is a certain amount of evidence that the coraco-brachialis (C.7), supinator (C.6) and rhomboids major and minor (C.5) are unisegmental. The unisegmental muscles are employed for producing fixation rather than range of movement. Yet the delicately co-ordinated muscles of the eyeball are essentially unisegmental, and the static lower limb in Man contains no unisegmental muscle. Sherrington states that in the monkey, *M. rhesus*, the tensor fasciæ femoris is supplied by one spinal segment only (L.5), as compared with three spinal segments (L.4, 5, S.1) in the superior gluteal nerve of Man. He disproved the claims made by Forgue and Lannegrace that the peroneal muscles are supplied by one nerve segment. Corresponding to the sensory overlap in the dermatomes there appears to be a longitudinal motor overlap in the ventral horn cell columns of the spinal cord. So complex is this problem of the longitudinal motor cell columns of the cord, that much embryological work remains to be done.

From the clinical point of view it is worth while examining in particular the actions of those muscles which have a dual innervation. Such muscles fall naturally into two groups. The first group consists of muscles which have been formed by the fusion of two muscles, both of which belong either to the primitive ventral or dorsal sheet in the limb bud:

<i>Pectoralis major</i>	...	...	...	Clavicular head (preaxial)	...	...	C. 5, 6
				Sternal head (postaxial)	...	...	C. 5, 6, 7, 8, T. 1
<i>Subscapularis</i>	...	...	...	Upper subscapular nerve	...	...	C. 5, 6
				Middle subscapular nerve	...	...	C. 6, 7
				Lowest subscapular nerve	...	...	C. 6, 7, 8
<i>Flexor digitorum profundus</i>	...	...	...	Digits II and III. Median nerve	...	...	C. 7, 8
				Digits IV and V. Ulnar nerve	...	...	C. 8, T. 1
<i>Adductor magnus</i>	...	...	...	Pubo-femoralis. Obturator nerve	...	...	L. 2, 3 (4)
				Ischio-femoralis. Obturator nerve	...	...	L. 2, 3, 4
				Ischio-condyloideus. Sciatic nerve	...	...	L. 4, 5, S. 1

In certain cases compound muscles are formed by the union of muscles formed from the dorsal and ventral sheets at the preaxial or postaxial border of the limb:

<i>Brachialis</i>	...	...	...	Main part. Musculo-cutaneous nerve	...	...	C. 5, 6
				Preaxial part. Radial nerve	...	...	C. (5), 6
<i>Biceps femoris</i>	...	...	...	Long head. Tibial nerve	...	...	S. 1, 2, 3
				Short head. Peroneal nerve	...	...	L. 5, S. 1, 2
<i>Pectineus</i>	...	...	...	Femoral nerve	...	...	L. 2, 3
				Occasionally Obturator nerve	...	...	L. 2, 3

The muscles of the thenar eminence, as recently described by Highet, still await solution both in terms of the actual nerve supply and the segmental origin.

It must be stated clearly that the existing accounts in the various textbooks of the actual segmental nerves involved in the cutaneous nerves, voluntary muscles and pilo-motor areas of the efferent thoraco-lumbar sympathetic outflow are at variance. Much of this is due to extensive transfer of the data accurately obtained by Sherrington in the cat and monkey, and by Langley and Anderson in the cat, to Man, without any thought for the differences in the number of thoracic and lumbar vertebræ and nerves in these various forms. Another source of difficulty is due to the manner in which the main branches of the plexus of the limbs frequently display irregular arrangement of the nerve fibres. In the upper limb plexiform variants involving fibres of the median nerve and musculo-cutaneous nerves are common, many of the median fibres running part of their course with the musculo-cutaneous nerve, or conversely some of the fibres of the latter running for some distance with the median. Finally the existence of intraneural plexuses whereby motor and sensory fibres sort themselves out in the course of the main nerve trunks is accepted. It is these very anatomical differences which make the search for the underlying principles so entrancing.

#### PREDISPOSING FACTORS IN INJURY OF THE PERIPHERAL NERVES

The peripheral nerves are damaged by stretching, pressure or interference with their blood supply. The rate and order in which the constituent fibres of the mixed nerve cease to conduct in response to these three types of injury is still a matter of doubt. Most observers agree that in pressure on a nerve, the motor fibres are affected before the sensory. In the case of stretching many observers state that the sensory fibres are involved before the motor, but many hold the contrary view. Even the relationship between rate of involvement, diameter of the fibre and rate of conduction in the fibre is perplexing. It is not known with certainty whether the diameter of the fibre of a cutaneous nerve is dependent on the length of the nerve fibre, e.g. the fibres of the cutaneous nerve of the

arm compared with the much longer fibres in the dorsal cutaneous of the forearm or the saphenous nerve in the lower limb.

Broadly speaking there is a direct ratio between the size of the fibres and their rate of conduction so that coarsely medullated fibres from  $20\mu$  to  $8\mu$  in diameter, subserving motor impulses to voluntary muscle, and sensory fibres of touch, pressure and joint sense conduct the impulses at velocities ranging from 100 metres to 40 metres per second. Finely medullated fibres transmitting heat, cold and pain range from  $6\mu$  to  $3\mu$  in diameter and transmit impulses at 30 to 15 metres per second. The sympathetic and parasympathetic fibres range from finely medullated fibres of  $4.5\mu$  to non-medullated fibres of  $1\mu$  and transmit impulses at velocities ranging from 12 metres per second to 0.3 metre per second. In short the rate of conduction of the nerve impulse in the last group is slower than the rate of conduction in the muscle fibres in the A—V bundle of His in the heart.

There are certain nerves in the body which live dangerously on the verge of hazards. The 6th cranial nerve with several bends along its course, the fibres of T.1 in the ulnar nerve with a perilous course over the neck of the first rib, its liability to stretch and pressure in relation to the internal condyle of the humerus and coronoid process of the ulna and its sharp bend around the hook of the unciform. Similarly some of the fibres of the 4th lumbar nerve emerge forwards from the intervertebral foramen, run downwards in front of the transverse process of the 5th lumbar vertebra, dive backwards under the sacro-iliac joint and then turn acutely outwards to run in the superior gluteal nerve almost to the anterior superior iliac spine, supplying gluteus medius, minimus and tensor fasciae latae. The fibres of the 6th cranial, 1st thoracic and 4th lumbar nerve require careful examination in the whole length of their course, for they may be involved in injury, or changes due to occupation, posture or age.

#### CONCLUSION

The study of Physical Medicine requires some acquaintance with the history of the development of our knowledge of the nervous and locomotor systems. The student must be acquainted with such landmarks as were set up by the pioneers, Goodsir, Herringham and Sherrington, amongst many others. Acquaintance with the hypotheses and conceptions of our predecessors, fallible though many of them be, is a pre-requisite to the statement of our present knowledge. This brief survey exemplifies a few of the points relating to the anatomy of the peripheral nervous system. It is as yet impossible to state the part played by Nature and that played by Physical Medicine in healing injury and disease of the nervous system.

#### SUMMARY

A description of some of the historical aspects of our present knowledge of the peripheral nervous system with special reference to the significance of the segmental nerve, the innervation of the skin of the limbs, the morphology of the brachial and lumbo-sacral plexus, and the clinical importance of the ventral and dorsal axial lines.

The segmental innervation of the muscles of the limb is discussed, in particular muscles with a double nerve supply and the intrinsic muscles of the fingers and thumb.

The 6th cranial, 1st thoracic and 4th lumbar nerves are peculiarly susceptible to hazards.

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# Section of Epidemiology and State Medicine

President—E. H. R. HARRIES, M.D.

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## DISCUSSION ON DENTISTRY IN RELATION TO STATE MEDICINE AND POST-WAR PLANNING

Major General J. P. Helliwell: The question of the relationship of dentistry to State Medicine could probably be more ably considered if it were possible to make even a rough estimate of the extent to which dental disease affects the general health of the community. There, from the start, we are plunged into an atmosphere of conjecture. How far is tooth decay a comparatively harmless process in the elimination of tissues for which we have a diminishing need, how far is dental disease if acting as a component part of a vicious circle, an indication of an individual's diminishing resistance or how far is it the circle's actual starting point?

It is only in the prevention of dental disease that dentistry can properly be included in State Medicine. Demolition and clearance of the ruins followed by rebuilding should be the last resort in State dental service. This service can have only one aim as its contribution to the general well-being of the individual and that is the preservation in a healthy state of the natural teeth and gums.

Dental service is primarily a service for the young. It is necessary throughout life as a continuation service, but unless a child is placed under dental care and supervision from its earliest age, it will often not be possible to ensure that he derives the maximum benefits from that service. A preservative service on these lines would be a sound national investment. The present wasteful rescue service deals, for the most part, with conditions when damage has already been done.

Dentistry, as at present practised, is to a large extent a frustrated calling. The aims and ideals which most young practitioners would like to apply to the great advantage of the public are too often upset by the ignorance and apathy of the people themselves. There are several causes for this attitude, but probably the most important one is the almost total lack of knowledge of the elements of physiology and personal hygiene and of the simple precautions to be taken against disease. Coupled with this is the fear, not altogether unfounded, of the pain of treatment and, finally, there is the undoubted factor that, in the public dental service in the past, a good deal of very indifferent conservative dentistry has been carried out and the confidence of a large proportion of the public in this type of work has consequently never been really captured.

In considering the state of Public Dental Service at the present time we must review the existing arrangements: Maternity and Child Welfare Service; School Dental Service; National Health Insurance Scheme; Hospital Dental Services; the Dental Services of the Navy, Army and R.A.F. together with other services, both official and voluntary, which afford some dental care to the poor.

In spite of these services, the chief fact with which we are now faced is the large number of people who at an early age have lost their natural teeth and are wearing or requiring artificial substitutes. I do not think that this is the result which would be seriously expected as the ultimate goal of a profession aiming at the preservation of the natural dentition, although from the official point of view it may have some advantages.

The dental condition of the pre-elementary school child is, generally speaking, almost entirely neglected and when he presents himself for his first dental inspection on entering school it is not uncommon to see rows of temporary teeth decayed to the gum level, combined with a generally septic condition of the surrounding tissue. 1,600 school entrants seen for the first time by officers of the Eastman Dental Clinic revealed an average of 4.95 decayed teeth for each child inspected. This is a demonstration of the degree of success, or failure, of any dental treatment received in their pre-school days.

During elementary school life one definite and good result is attained. Dental sepsis of a nature damaging to health is kept down almost completely, by the annual inspection of the children and the removal of badly decayed teeth. The primary intention of the school dental service goes, however, far beyond this, for it envisages the preservation of the child's natural teeth and the prevention of the evils due to their premature loss.

Unfortunately the school dental service has never been capable with the limited personnel provided of giving the children that complete care which is essential to success. The school dental service has never been either sufficiently preservative or really educative, because sheer numbers have so often prevented the best standard of treatment being carried out or early attention being given to carious teeth, with the result that much of the work has been neglected or has failed. The parents have consequently often lost confidence in conservative work and the educative effort of the service has to a large extent been wasted.

There are some outstanding exceptions, however. In the Cambridge Borough, the school dental service under the direction of Mr. Grandison is so good as to attract 95% parental consents for treatment.

A good dental service obviously has its own educational value. This can often be well demonstrated in residential schools or orphanages, where there is a regular supervision of the children's teeth and the dental surgeon has the time, facilities and inclination to help in really first-class social service. He is, moreover, removed from the opposition of parents. Children of all ages up to 14 or 15 in some of these schools show what a really first-class service can do for them. Seldom do they have anything seriously wrong with their deciduous teeth and such caries as may commence in these or the permanent teeth is dealt with at once. Toothache is almost unheard of and the extraction of permanent teeth is, for the most part, an operation for orthodontic purposes. Such children have, of course, many advantages over other children in that they lead regular lives, have a well-balanced diet and in the main do keep their teeth clean.

After children leave their elementary school, there is at present no definite organized service in which, even if they are employed, they can receive systematic dental treatment for some years, because they are not yet eligible for any dental benefit under the National Health Insurance Scheme. Whilst they are waiting for this health benefit to mature, disaster is occurring in their mouths. Schemes already exist in two boroughs—Cambridge and Guildford—for the continuation of treatment, at a small charge, of adolescents after they leave school.

If effect is given to Sir William Beveridge's recommendations, this gap between school dental benefit and insurance dental benefit will disappear.

The National Health Insurance Scheme affords dental treatment as an additional benefit to those members of Approved Societies who have qualified for it. As a rule, a part of the cost is borne by the patient and part by the Approved Society. The scheme generally calls for three main comments: firstly, that only insured persons are eligible for the benefits; secondly, that the benefit, when given, commences far too late to be of the best value in the preservation of the natural teeth; and thirdly, and consequently, that the service seems to be largely demolitional instead of preservative in nature.

Dental service for in-patients in general hospitals is, for the most part, concerned with removing focal sepsis, as part of the general treatment of the patient. In addition, there are, of course, those special dental cases for which admission to hospital is advisable. Dental out-patients in hospitals are generally poor, uninsured people presenting themselves for casual treatment or denture work: but such treatment is not systematic enough to be of any great national service. An exception must be made in the case of dental schools and dental departments attached to the large voluntary hospitals, where the highest standard of treatment is carried out.

Perhaps the most systematic adult dental treatment in this country is carried out in peacetime for the fighting services. Men are made dentally fit on entry and inspected and treated regularly during the whole of their service. There is, however, no special provision for keeping them fit while they are in the Reserve.

The highest standard of systematic dental service should be regularly available to all throughout their lives. The public would learn to appreciate that service and not only seek it but insist upon it. The primary essential for such a service is the realization by the public of the value of a healthy mouth as an integral part of a healthy body. By a healthy mouth I mean a mouth with well-preserved and well-cared-for teeth in it.

Instruction in elementary physiology, personal hygiene and the prevention of disease should form an important part of the education of all children.

As at present constituted, the dental profession could not deal with a demand for such service. It is a demand, however, which will—fortunately for the profession—become apparent gradually, and we will not be without time to prepare for it. In the first place, it must be decided whether dentistry is to remain in—or to return to—the mother profession of medicine. If it cuts itself off further, it is difficult to see how it will be possible for dentistry to attain that degree of the public confidence for which it yearns. The training of dental personnel should be so modified that certain work and duties of a nature not

requiring complete surgical training can be delegated to personnel specially trained for these tasks. Take, for instance, the cutting out of early dental caries, scaling of teeth, the surface treatment of deciduous teeth and other simple operations that do not require for their performance the highest standard of professional knowledge. All these operations could be carried out by well-trained and certificated dental operators or nurses (who would generally be women) acting on the instruction of the qualified dental surgeon. By well-trained dental operators I mean persons of good general education, who have undertaken a well-planned course of instruction and have attained technical proficiency both in these duties and in assisting the dental surgeon as a dresser. Thus there would be no question of entrusting work to inadequately trained personnel. This would enable the dental surgeon to give his time to consultation, the direction of the more simple treatment into the proper channel, the general supervision of the dental service and the performance of all those operations requiring definite surgical procedure. In dealing with deformities and injuries in the mouth and jaws, for example, he would be more the surgeon and less the mere maker and adaptor of splints and appliances. In fact, the dental surgeon would be placed in the position of any other specialist-surgeon who is able to carry out all surgical procedure in a well-planned and systematic manner and generally to control the activities of all working under his direction.

Probably the main reason for the partial divorcement of the dental profession from the parent body has been the desire to retain for itself the profits of dental plate making. The dental surgeon should have no part of the profits arising from the sale of false teeth: a condition it should be his one endeavour to prevent. In my opinion, the denture service is rightly the preserve of the dental mechanic or technician. It is he who has largely built it up and it is he who does the work. It would be a short step for him to undertake the comparatively simple tasks of taking impressions and fitting the finished dentures, thus placing himself in line with other makers of artificial appliances. The dental mechanic would not, of course, fit orthodontic appliances of any kind or fit any fixed appliances.

If the simple tasks of prophylaxis were undertaken by properly trained and registered dental operators under the direction and control of the dental surgeon and if denture work were carried out *in toto* by trained and registered dental technicians, the dental surgeon would be able to devote himself to surgical operations, to research, to orthodontics and to the supervision of the general dental health of the individual.

After the right type of dental service has been in force for, say, a generation, we shall arrive at a position in which only the simplest form of operation is needed in a large percentage of cases to arrest the progress of dental disease. This will be particularly so in the pre-school and school age and also, it is hoped, in the continuation services which follow. The better the system of dentistry adopted, the more simple dentistry will become. In fact, dentistry, for the most part, under the system aimed at, would become a series of comparatively simple tasks requiring routine technique. This should account for at least 80% of the dentistry required by the people, especially for children and young adults, and it would not demand people as highly trained as the modern dental surgeon to carry it out. He would be occupationally unsatisfied by it and his service and individuality would inevitably deteriorate. Further, the public should not be asked to pay for a degree of service it does not require.

At the present time difficulty is experienced in obtaining the number of dental students necessary to replace wastage in the profession and if, in the future, dental service becomes more routine in character, it is hardly likely that more candidates will embark upon the lengthy, expensive and complete course required of the dental surgeon. Yet a great increase in practitioners is essential and in my opinion the trained operator would not only fill the need but would very quickly be regarded and welcomed by the dental surgeons themselves as an essential part of the public and private dental service. In public dental service there would be a proportion of four or five operators to one dental surgeon. But let there be no misunderstanding. I am suggesting that work within certain limits should be undertaken by people with the highest degree of training for it. The dental operators would be quite as highly trained for it as the dental surgeon and they could, within these limits and under direction, be relied upon to give excellent service. They would simply march with personnel in other branches of medicine and surgery, whereby certain tasks and tests are delegated to special nurses and technical assistants. These dental operators should not in any way be confused with dental attendants. They would be in a special category and they themselves would require the assistance of dental attendants. Nor should they be confused with dental dressers who have been given a short period of training in order to fit them for the scaling and cleaning of the teeth of Service men during the present emergency. The success or failure of these dental dressers should



in no way be used as an argument for or against the dental operators I have in mind. Actually, these dressers would be of little practical use in the school service where the operator would be chiefly engaged.

The dental surgeons themselves should come into line with other surgeons by having a basic qualification in medicine and surgery. At the present time, the profession of dentistry seems to be in a rather uncertain position with a pull towards the parent body of medicine on the one hand and with an urge towards independence on the other. The pull towards medicine is understandable in view of the historic associations which have not been entirely severed, and it is difficult to see what advantages dentists would gain in an absolutely independent profession. It would be difficult, indeed, however the profession may emphasize its independence, for the public to differentiate it from the auxiliary branches of medicine and surgery and to accord it the confidence which is so necessary for success. A considerable percentage of dental surgeons do feel the need for the broader outlook of the full medical education and there is no doubt that many would have taken the qualification if the curriculum had been slightly modified to make it easier for them to do so. This need has apparently been realized by the University of Manchester, where, I understand, the first and second examination for medical and dental degrees are now identical, and much credit must be accorded to Professor Wilkinson for his long view in this direction. The dental surgeon of the future will seek the fullest collaboration with all branches of the medical profession by actually belonging to that profession. I think he will prefer this and the confidence it will bring with it to the uncertainty and hesitancy which must go with separation unless, of course, he frankly accepts his position as a member of an auxiliary service. There can only be equal co-partnership if the partners are equal. It has to be remembered in this connexion that most of the time now spent by a dental student in the construction of artificial teeth could be utilized in his general medical training.

As regards facilities for dental treatment, it is of course essential that they shall be made available to the patient in the easiest possible way consistent with efficiency. This must always be an important factor in inducing patients to take advantage of the service offered. The question of sparing the time and money to make many visits to a remote dental centre is an important one and wherever possible the service must be taken to the people. It will be necessary for the dental service to take its proper place in the general medical arrangements and medical centres should generally be properly equipped for all kinds of dental work. I imagine that there will be health centres in all towns, and possibly even in some of the larger villages, which will serve the immediate neighbourhood, and as far as dental treatment is concerned, they would deal with adults and undertake the more special treatment for children. I think that if the ordinary conservative dental treatment of children is to be a success it should usually be carried out in the schools and every school should have a suitable room set aside for this and other minor ailment purposes. This arrangement would be more satisfactory than the travelling dental surgery. One naturally anticipates that electric light and power will be available by the time such centres are established, in order that modern methods may not be denied to the children. Another advantage of carrying out conservative treatment in the schools is that the supply of patients is assured, the dentist's time is not wasted and it is not necessary to inconvenience the parent. Extractions and special treatment such as orthodontics would ordinarily only be undertaken at the health centres by the dental surgeons, but under a sound scheme of preservative dentistry, extractions for children would be less usual than at present. The pre-school child should also be treated at the school clinic, unless the health centre is more convenient for the parent.

The primary inspection of the pre-school child should be carried out by the dental surgeon who would make reinspections at certain stages during childhood and adolescence—say at intervals of three or four years, unless there were special reasons for the child to be seen by him more frequently. In ordinary cases, the routine inspections—probably biannual—could be undertaken by the dental operator, who would also carry out the bulk of the conservative work in the schools. Dealing with commencing caries in children's teeth would, in fact, be the chief function of the dental operator.

The initial inspection of all cases, whatever the age may be, will be the duty of the dental surgeon. The dental record and history cards will be initiated by him and the service to be given will be prescribed by him. His job will be responsible and in all ways satisfying to a man of his special education and it will open up a wide field of endeavour and public usefulness.

Dental equipment for public service should be standardized and the clinics equipped according to their special requirements. All articles and materials should be kept up to date. Some latitude should be allowed to the individual in the choice of expendable articles.

What is the probable size of a general dental service for a population of about 45,000,000? All figures must be given on the assumption that the scheme of treatment is in full force and that all initial treatment had previously been carried out or, alternatively, in case a fresh start has to be made, on eventual requirements if from a definite date all children in the lowest age-groups are dealt with and they and all who follow them are given such regular treatment as they require throughout their lives. Generally speaking, children and young adults who were or have been made perfectly fit dentally will show a recurring need of treatment to the extent of about 50% annually, and of course this recurring number includes the constant repetition of all those children who are more prone to dental disease than others. The children under 6 require less time than the older children; the incidence of dental caries diminishes after the age of about 30 and after 40 is a comparatively slow process. On the other hand, even in normal times, pathological conditions of the supporting tissues of the teeth become more evident in many adults and may require much attention if the patient is to retain his natural teeth. Some twenty-five million people would probably require treatment each year.

Experience shows that one dental surgeon can give the dental care and attention necessary under good present conditions to about 1,450 school children each year, but it is possible that, as better treatment can be given by dealing with them at an even earlier age, this figure might undergo slight revision—though probably not to an appreciable extent. Adults can probably be treated at about the same rate as children.

Dental treatment in public dental clinics should be free to all and I base this opinion primarily on the assumption that everyone will be taxed or will pay rates for the cost of the service, according to his means, whether he takes advantage of it or not; and secondly, because where there is a difference in remuneration for a service of this kind, it frequently follows that there is some discrimination in the type of treatment. It is essential that the clinic standard of treatment should be equal to the best private practice standard.

In any reorganization of the dental service there should not be too many so-called administrative officers. A large service needs its director or its consultant and he may require his regional or district representative, who may be a whole-timer, or he may be able to give part of his time to professional work. With precise instructions as to duties, procedure and supplies, however, it is found that the average dental officer can get on very well without very much overseeing. The dental administrator should be included in the general medical administration, as in the case of the other special surgical branches and, of course, the dental surgeon, if he is qualified for it, should have his fair share and chances in this general administration.

It has to be understood that any large dental reforms could not be put into full effect for a considerable time—not until the attitude of the public is more appreciative and also not until the dental service is able to cope with them. It is perfectly certain that some years must pass before the approach to the full changes are obvious and few at present in the dental profession will be greatly affected by these changes. There will be a far greater interest in scientific dental research chiefly directed towards the prevention of dental disease. Before everything else, this field of prevention must be explored. The field of treatment also can be vastly improved and if we are to give the public its due, we must aim at abolishing pain during and after all dental operations. This is well within our power now and there is no reason why fear should be an obstacle to the willing co-operation of the public. Conservative dental operations very often require a considerable amount of courage on the patient's part if we do not use the means at hand to avoid the acute pain of cutting sensitive dentine. Further, such measures make the operations easier for the operator and generally enable him to do a far better job. Our present custom of violently tearing tissue from tissue and distorting bone in the process of extracting teeth will undoubtedly be looked on as barbaric by the dental surgeon of the future. His method may be the more gentle one of surgical removal, adding greatly to the patient's comfort during and after the operation. We must commence our treatment by giving good care and attention to deciduous teeth from the time they erupt until they are shed, if we wish to give the best chance to the permanent teeth both as regards structure and position. We should take special care of the teeth of ante-natal patients and at the same time educate them in the care of the children's teeth.

The dental treatment of ante-natal patients is being successfully undertaken at some of the London County Council's general hospitals and conservative treatment is becoming increasingly popular. This success I am confident is due to the efforts of the hospital dental surgeons in giving a high standard of conservative treatment painlessly to the patients and at the same time putting in a word in season on the value of teeth generally.

[As I hold an appointment with the London County Council it remains for me to say that the views I have expressed are mine and may not be considered as necessarily those of the Council.]

Mr. A. E. Rowlett: I sympathize with General Helliwell's desire to see Dentistry a specialty of Medicine. Such a desire expresses the ideals of a large number of dental surgeons.

That this general desire has not resulted in dentistry becoming a specialty of medicine is not due simply to the obvious difficulties of time, expense and aptitude for study.

The crux of the problem lies in the fact that dentistry's chief concern is with the tissue of the tooth that is unlike any other tissue of the body. It is not only more subject to disease than any other tissue in the body, it is feebly, or wholly unresponsive to systemic therapeutic treatment, and it has no power of replacing the lost tissue by scar, though the diseased areas are walled off from the cell community, but any tissue damage resulting from disease or operation must always be restored artificially. In other words, in order to carry out his task adequately, the dental surgeon requires a long, specialized training, which demands not only natural manual dexterity, but the acquired mastery of many delicate techniques in addition to a sound basis of surgical and medical knowledge. Up to the present time, no curriculum has yet been devised that supplies in a reasonable period training which covers these two fields of activity, i.e. the field of medicine and the field of dentistry. It has thus come about that the possession of an additional medical qualification does not necessarily guarantee that a man is a better dentist, but only that he is potentially a better dentist.

On the other hand, it is generally agreed that a British Licentiate in Dental Surgery who has in addition acquired a dental degree from a high-grade American University, is in possession of knowledge which enables him to do better dentistry for the public which he serves.

Major-General Helliwell recognized this difficulty when he suggested some modification of the surgical curriculum. The Harvard University has made a practical endeavour to furnish this dual training. The basic principles of the new Harvard Plan, as given in a letter from the Dean, Dr. Le Roy Miner, in December 1942, are as follows:

Admission requirements to the new School of Dental Medicine are the same as those for the Harvard Medical School and a first-year student entering the School of Dental Medicine will register both as a student in this school and as a student in the Harvard Medical School. The original plan was to carry the student in the School of Dental Medicine through five academic years of work, at the end of which time he would receive an M.D. and a D.M.D. degree. During these five years he would have courses in both medicine and dentistry and it was originally thought that by concentration of courses the work of the two disciplines could be accomplished in five years. Careful study of the problem, however, soon revealed that this was not possible if the man was going to be as well trained in medicine as the medical men are now trained, and as well trained in dentistry as their dental graduates are trained, so it was found necessary to extend the time by an academic year. The plans are very much in the formative state.

Dr. Le Roy Miner stated that this programme is by no means a new one as medical graduates at Harvard could always receive an additional dental degree after two years of intensive work. The real advance seems to lie in the fact that the preliminary or pre-professional training of the dentist is to be equal to that of the medical man. This, it appears, had not been the case in America in the past.

In discussing this scheme with the Dental College in America in 1941, I have found that there was a considerable amount of opposition to the Harvard Plan because it was so completely medically dominated. The principle of autonomy for dentistry is a vital matter with most American dentists. There was also a feeling that it would not be possible to give an adequate training in technical methods of operating in so comparatively short a curriculum when such a great part of the time was given up to medicine and the general opinion seemed to be that it would be more valuable for training men who would ultimately become teachers or research workers.

Major General Helliwell's project of creating a class of dental operators would seem to be fraught with dangerous contingencies. It is not easy to define the term "simple operation" and the limited training of these men or girls would almost inevitably lead to a sense of occupational dissatisfaction.

An approach to this problem of the relationship between dentistry and medicine can be made by estimating the position which dentistry has reached to-day and then comparing it with that of medicine.

The position of medicine has been made clear by the various reports, such as the draft plan of the Medical Committee of the British Medical Association for the Beveridge Report, the Socialist Medical Report and others, and it is clear that they are at one upon

the fundamental point of positive health and a comprehensive medical service and rehabilitation.

Dentistry, as an organized profession, only dates from the year 1878 and is thus only sixty-five years old. During this comparatively short, but eventful, career, it may be described as passing through three overlapping phases: the Mechanical; the Focal-sepsis or Surgical; and the Prophylactic or Oral Hygiene Phase.

*The mechanical phase.*—In 1878 the prospective dental surgeon spent the first three or four years as an articled pupil to a registered dentist. Those vitally important years were spent in the dental workshop. Whether or no he made any studies whatever in the basic sciences depended upon the type of man to whom he was apprenticed and the town in which he was located. At the end of his apprenticeship he went to a hospital, where he pursued his studies for two years and at the end of this time was eligible to sit for his examination. Broadly speaking, this training tended to turn out men with a sound practical knowledge of dental mechanics, were good extractors and were capable of doing good hammered gold fillings. They had a good anatomical, surgical and physiological background, but were entirely devoid of any knowledge in dental pathology or ætiology.

*The focal-sepsis phase* may be said to have started about the year 1900 when the famous lectures were given by Dr. William Hunter on focal-sepsis and the anæmias. Pyorrhœa became a fashionable complaint and conservative dentistry received a severe setback and though much sepsis was very properly eliminated to the great benefit of the patients, many sound teeth were sacrificed unnecessarily, a practice which is prevalent in social dentistry to-day. All this time, owing to the imperfection of the 1878 Act, unregistered practice was increasing and finally attained such menacing proportions that in 1921 an Amending Act was passed.

*The prophylactic or oral hygiene phase* has been introduced during the past twenty years. Dental pathologists and histologists by their researches in parodontal disease have enabled the dental surgeon to assure his patients that in the large majority of cases pyorrhœa can be prevented and, if too much tissue destruction has not taken place, cured. At the same time, notable advances in the ætiology of dental caries have been made, particularly in the United States. The susceptibility of patients to dental caries can now be estimated with fair accuracy and methods for the arrest and prevention of children's caries by diet have been developed.

Thus, almost unnoticed, dentistry entered its third phase of prophylaxis and oral hygiene. By-products of this third phase would be the education of the public and concentration on the health of the young from the moment of birth, which in its turn must inevitably include the closest co-operation with the medical profession, and adequate dental attention to and education of the school child. At the same time, and in the dental schools, the attention of the students would be focused upon healthy tissue instead of diseased tissue.

Whether this final phase will ultimately lead to dentistry becoming a specialty of medicine is a problem of the future. At present for all dental surgeons to become medically qualified is impracticable.

Dr. E. W. Fish was entirely in agreement with General Helliwell that "Dental Service is primarily a service for the young".

The School Dental Service should be efficiently equipped and fully staffed. This could only be done if it were made pre-eminently attractive to new graduates not only as to the type of dental work carried out in it but in respect of hours of practice, salary and prospects of a career with a bonus or pension on retirement, with all administration in the hands of members of the dental profession.

After a short term of years in this service many young men and women might wish to leave it and enter the wider sphere of adolescent or adult practice. Postgraduate refresher courses at a progressive postgraduate institution would be invaluable at this juncture and a bonus on retirement after perhaps five years would lead to a healthy flow of practitioners into adult practice from the School Dental Service and would make room for new graduates to enter it. In this way a new generation of dental surgeons would grow up with a new generation of citizens.

He would not agree with General Helliwell that the medical curriculum was the best form of education for a dental surgeon. For example, in chemistry the work of a doctor required a knowledge of quite different aspects of biochemistry from those required by a dental surgeon. As regards physiology the doctor deals mostly with the activities of the living cells, the dental surgeon with the inert intercellular substances made by one particular group of cells, those of the connective tissue. As their education proceeds the dental and medical curricula drift even further apart and medicine has made no corresponding approach. Some of the teachers in dental schools must obviously have the wider

perspective gained by a study of general physiology and general pathology, medicine and surgery, but this, he thought, was hardly necessary to the man in general dental practice. It was high time that an academic career was established in dentistry and an adequate curriculum was worked out. This deficiency must be made good before any successful scheme of National Dental Service could be carried through and no less urgent was the necessity to increase the entry to the profession and enlarge the schools to cope with it.

Treatment of the existing adult population, an extremely high percentage of whom have neglected mouths, was complicated not only by the enormous cost involved and the shortage of available dental man-power, but by the unequal distribution of demand. Universal benefit on a *per caput* basis coupled with a high demand by the well-to-do and a negligible one by the poorer sections of the community, who do not value dental treatment, would mean that the latter would be paying for the treatment of the more prosperous section of the community. The dental surgeon in a residential district, where the demand for his services was total, would, however, be compelled to move into an industrial district where the demand was low, so that confusion would reign. It would, nevertheless, be possible by establishing suitable safeguards to offer everybody the "possibility of dental treatment" and yet in effect to confine it to those whose need was greatest. The most important thing, however, was to couple this with a progressive scheme to care for the new generation as it grows up, and having laid a good foundation to watch over the dental health of these young people all their lives.

The unfolding of any scheme must be gradual, for in attempting to increase the numbers of the profession it must take a generation to reach the pre-arranged target figure; and in dentistry a generation is thirty-six years. If the target were 20,000 the new entry would have to be 560 a year and the academically qualified section of the profession would then increase at the rate of 280 p.a., most of whom should be attracted into the school service; but even to attain this slow rate of progress an immediate start must be made to train new teachers for the dental schools so that they may be enlarged to deal adequately with the influx of students on demobilization.

Mr. Somerville Hastings said that the dental surgeon of the future should act more in a consultative capacity than he did to-day. He did not think that a long time lag should be looked upon as inevitable and would advocate the suggested reforms being commenced with the least possible delay.

Mr. H. Alvin Mahony said that hardly more than a third of the children attending school actually received treatment in any year, and in spite of the extent to which public dental services had been provided in the interval, there was reason to doubt if the dental condition of the young recruit of 18 to 19 was any better in this war than it was in the last. The gap between school leaving age and eligibility for dental benefit under the National Health Insurance Scheme had been generally blamed for the dental condition of the young adult, but recent investigations had drawn attention to the very high number of adolescents of 16 and 17 whose dental condition was such that the only possible treatment was the extraction of natural teeth and their replacement by artificial dentures. It was difficult to imagine that the dental condition had deteriorated to an extent in the two to three years after leaving school. There was no doubt that the problem was not being adequately met by present arrangements.

One of General Helliwell's suggestions was that, for what was estimated to be 80% of the treatment necessary, a service of persons with a restricted training and function should be set up. Any Government Department or other Body which was responsible for a revision of dental arrangements would have to consider whether the public would be content that their dental needs should be dealt with by this lower grade of dentist. On the other hand, it was suggested that every dental surgeon should receive full medical training. He remembered that the Dean of one of the dental schools laid down as a principle on which he advised prospective students that the attempt to take medical and dental courses concurrently in anything like the minimum time would result in the production of neither good dentists nor good doctors.

If it were necessary in order to secure the right type of dental surgeon that he should undergo the full medical curriculum with an additional two or three years for special dental subjects, it might be appropriate to consider whether, under those circumstances, he would not be entitled to superior status and higher pay than the man who had a medical qualification only. He doubted if many of the subjects of the medical curriculum would be of any real value to a man who was going to practise dental surgery.

He paid a warm tribute to General Helliwell's valuable work in the establishment of the Army Dental Service and to the high standard of conservative work which he had always understood General Helliwell attributed to the efficient system of supervision in that Service. He was able to say from information obtained by the examination of ex-

Servicemen who came under other dental schemes in later life that conservations carried out in the Services remained efficient even after the lapse of many years, and this was confirmed by the conditions found in Service patients examined in hospitals in the present war. He was, therefore, surprised that General Helliwell should now contend that the amount of supervision of dental work which was required was small, and from his own experience, he was unable to agree with this suggestion.

Mr. C. Bowdler Henry said he shared the view that reorganization of the dental curriculum was necessary. It was not generally appreciated that this curriculum was in the first instance a compromise, aiming as it did to eliminate quackery by combining the more reputable artificers with the surgeons. About eighty years ago quackery was rife and dental surgery was not recognized by the Council of the Royal College of Surgeons. There were, however, two sets of reputable practitioners, one consisting of fellows and members of the Royal College who desired to practise in the specialty, the other consisting of craftsmen, mainly adaptors of artificial teeth, but unqualified in medicine or surgery. Some of the latter were educated people, at least one of them (Samuel Cartwright, Senior) becoming F.R.S. and more than one being Fellows of the Linnean Society. The granting of the L.D.S. by the Royal College of Surgeons in 1853 was the successful culmination to ten years of assiduous petitioning, both to the Royal College and to Parliament, by a group of representatives of both parties led by John Tomes.

Their petition was only granted after they had formed themselves into the Odontological Society of London, of which they constituted the Council, and had produced not only their proposed curriculum of study but also a place in which to teach it. Their school, and the charity which they founded to serve it, was the institution which is to-day the Royal Dental Hospital and it may be said that the tale of the birth of this school is the history of regulated and scientific dentistry in Great Britain. The Odontological Society exists to-day as the Odontological Section of the Royal Society of Medicine, of which it became a founder section.

It is recorded in the speeches of Sir John Tomes that the dental curriculum was drawn up to be equal to that of medicine in period of study, expense and in cultural attainments, the requisites of preliminary education being the same for both. The only difference was that two-fifths of the medical training not deemed necessary for a dental surgeon to know were omitted and in their place an equivalent amount of pure dentistry, mainly prosthetic, was substituted. This curriculum remains to-day and in assessing its suitability to modern requirements, it is necessary to take note of the original state of dental practice and the changes which since then have taken place.

When the curriculum was drawn up, artificial dentures were still being made from ivory of the walrus tusk, dental plate and teeth often being carved out of a single block of the material. This was work which required high craftsmanship. In succeeding years, however, the introduction of new denture materials, especially the plastics from vulcanite onwards, has ceased to require this high degree of craftsmanship, whereas the biological aspect of dental therapy has assumed ever-increasing importance. Surely the time had now come when we should dissociate the craft of plate-making from the biological side.

We should have two sets of practitioners, the dental surgeons and the dental prosthetists, the former qualified in medicine and the latter trained in the craft.

Mr. J. Campbell said that many of the younger practitioners thought that there was a distinct need for the type of assistant advocated by General Helliwell and that they would be of valuable service to the profession. He would like to see the whole of the recommendations advocated in the opening address put into effect.

Mr. W. Kelsey Fry said that although he agreed with some of Major General Helliwell's ideas, he could not go the whole way with him. He could not agree that the National Health Insurance Scheme had entirely failed. The age at which the patients received benefit under this scheme was such that nothing but a "break-down" service was of any value; as a service of this type it had done a considerable amount of good. A scheme for providing full dental treatment for the general public could only come into operation within a reasonable time if ancillary services were brought into action. The service which he considered would be of the greatest value at the present time was that of the dental hygienist. The dental hygienist would be capable of undertaking a great deal of the prophylactic dentistry, which at present could not be adequately carried out, and which certainly could not be dealt with in the post-war programme without a considerable increase in the dental personnel.

This particular ancillary service would be of special value for in-patients in the general hospitals. At present these patients received no prophylactic or conservative treatment, but merely urgent extractions. All in-patients should have dental inspection and prophylactic treatment.

Mr. J. F. Pilbeam said he was opposed to General Helliwell's suggestions. He did not consider that it was in the interest of the profession that dental assistants should be employed for the duties described nor did he consider that a medical qualification would be an advantage for dentists.

Major General Helliwell, in reply, said he did not fully agree with Mr. Rowlett that the double qualification was more necessary as a background for teachers and research workers—a view which seemed to be held also by Dr. Fish. He thought the teachers and students should always have a similar background. With regard to Mr. Rowlett's statement that no curriculum had been devised which covered the combined fields of medicine and dentistry he thought that this was probably due to the fact that dental surgeons were including in their work a considerable part which should be performed by auxiliaries and technicians.

The fear that dental surgery may become medically dominated would be groundless if dental surgery became an integral part of medicine.

The creation of a special class of operator would not be fraught with dangerous contingencies. He saw no difficulty in defining simple operations and did not think that the possible occupational dissatisfaction of the operators could be compared with that which would be felt by the highly trained dental surgeon of the future if most of his work was of a simple routine type. The operators in the public service would be chiefly engaged in dealing with "regular" patients in order to prevent the spread of caries beyond the earliest stages. They would be entirely under the direction of the dental surgeon and would not be called upon to deal with advanced dental or oral disease of any kind.

In spite of the changes in the dental profession from the mechanical phase to the prophylactic phase described by Mr. Rowlett, no drastic change had yet been made in the training of dental personnel and he suggested that the time was now ripe for it.

Dr. Fish had said he would like to see all dental administration in the hands of the dental profession. Were the chief dental officers of the different departments to be cut quite adrift from the medical administration? The tendency would then be for a big unnecessary dental organization to be built up which could not bear expert and unbiased scrutiny. Further, any independent director in an independent dental profession would hold a most unhappy and precarious office in attempting to administer a medical branch split off from the parent bodies. All the way down the scale there would be untenable positions such as, for example, a dentist on the staff of a hospital attempting to run an independent concern within a medical unit.

He was particularly interested in Dr. Fish's suggestion that a bonus should be given to school dentists after a number of years when they retired and made room for other young dentists. It was the knowledge of the feeling of lack of fulfilment among many dentists in a life consisting for the most part of school dentistry that had impelled him (General Helliwell) to recommend a few years ago a scheme for retirement with gratuity after a few years of such service but the dental profession would have none of it.

Dr. Fish had drawn a comparison between living cells dealt with by the doctors and the inert tissues dealt with by the dental surgeon. It was, of course, chiefly this inert tissue which he wanted the dental operator to deal with up to a certain point. That would eventually amount to 80% at least of the work in an established and well-organized service and there was no need for medically qualified persons to do this work, but there was very definite need for the dental surgeon who would do the other 20% of the work in, for the most part, living cells, and who would also have the full responsibility for the whole 100% of the work, to be medically and surgically qualified.

As regards Dr. Fish's suggestion of difficulties which might occur if dental service were provided on a *per capita* basis he again emphasized that the scheme would be progressive and that the rate of progress would be proportional to the demands of the public made as a result of education in health matters and on the quality of the service provided.

In reply to Mr. Mahoney, General Helliwell said that he had not recommended an inferior grade of dentist but a dental auxiliary to work under the direction of the dental surgeon in order to meet future needs. If an auxiliary service were not introduced there would be a tendency for the profession itself gradually to become, for the most part, a medical auxiliary. He agreed that adequate supervision of dental personnel was necessary but maintained that in a soundly organized service it would not be so great as was often advocated.

He agreed with Mr. Kelsey Fry that a considerable amount of good had resulted from even the "break-down" service to insured patients and in that sense the National Health Insurance Scheme had not entirely failed but it was that particular type of service that he thought they all agreed must be obviated as far as possible in future.

## Section of Neurology

President—R. M. STEWART, M.D.

[February 18, 1943]

### DISCUSSION ON RECENT EXPERIENCES OF ACUTE ENCEPHALOMYELITIS AND ALLIED CONDITIONS

Dr. Russell Brain : During the last two years I have seen 22 cases of acute encephalitis and 6 cases of acute aseptic meningitis. Of the 22 cases of encephalitis 6 followed measles, 1 mumps, 2 occurred after inoculation and 2 were of the so-called Marie-Strumpell type. The remaining 11 seem to fall into three clinical groups. In 6 the onset was acute or even fulminating with high fever and stupor or coma and 3 with meningeal signs had polymorphonuclear cells in the cerebrospinal fluid. In spite of the stormy onset recovery was complete in 5. In 2 further patients the onset was subacute and the course progressive to death in two to three months. In the remaining 3 the onset was subacute and the course at first relapsing; and there was evidence of considerable destruction of the white matter with permanent visual field defects and pyramidal lesions when the disease became arrested. Without attempting to apply clinical descriptions to them we may say that these seem to be three different patterns of reaction of the nervous system to infection.

I.—MENINGO-ENCEPHALOMYELITIS DUE TO PYOGENIC ORGANISMS.—(1) *Meningococcal encephalitis*.—Attention has recently been drawn to the occurrence of cerebral lesions in meningococcal meningitis. Banks and McCartney (1942) distinguish a fulminating cerebral type of meningococcal infection and a focal encephalomyelitis. The former is characterized by an acute onset with rapidly deepening coma, and in the most acute cases signs of meningitis may be absent and the cerebrospinal fluid clear. In the latter the onset is that usual in meningitis, but the response to sulphapyridine is unsatisfactory and signs of focal cerebral lesions develop. These may persist after recovery from the meningitis and be permanent. The high survival rate in meningococcal meningitis treated by modern methods has brought to light encephalitic sequelæ which previously were not often seen. The most common of these are symptoms closely resembling those of the post-concussional state.

(2) *Meningo-encephalitis complicating scarlet fever*.—In addition to the common intracranial complications of this disease a meningo-encephalitis characterized by a lymphocytic pleocytosis may occur. I recently saw an example of this in a boy of 6 who developed meningeal symptoms when his rash was desquamating. He was febrile for ten days and showed no response either to anti-streptococcal serum or sulphonamide. His cerebrospinal fluid contained 160 lymphocytes per c.mm. on two occasions. Neal and Harrington (1942) allude to this clinical picture and Lassen and Bang (1940) report 20 cases, an incidence of 0.2%. Is this meningo-encephalitis caused by the streptococcus or its toxins, or is it, as Lassen and Bang believe, caused by a virus?

II.—ENCEPHALITIS WITH INTRANUCLEAR INCLUSION BODIES.—During recent years several new forms of encephalitis due to virus infection have been discovered, Japanese B encephalitis, St. Louis encephalitis, the Western and Eastern forms of equine encephalitis and Russian encephalitis. None of these has so far been identified in this country. My series includes one example of a rare form of encephalitis of which only four previous cases appear to have been described, the characteristic feature being the presence of eosinophil inclusion bodies in the nuclei of the cortical ganglion cells. Dr. Greenfield will describe the lesions. My patient, a boy of 11, developed symptoms after antidiphtherial inoculation. The onset was insidious. Change in character was followed by impaired vision and ataxic gait. The distinctive clinical features were facial spasm, trismus, clonic movements of the right upper and lower limbs, and a right grasp reflex with left hemiparesis. The patient was comatose with double hemiplegia for five weeks before he died, three months after the onset of symptoms. The cerebrospinal fluid was normal. Though the reported cases are few (Dawson, 1933, 1934; Smith, Lennette and Reames, 1941; Akelaitis and Zeldis, 1942) the clinical picture is fairly distinctive. All the patients have been children, the course of the disease has been subacute rather than acute, lasting two to



four months, involuntary movements are characteristic, clonic in 3 cases, hemidystonic in a fourth. The cerebrospinal fluid has been normal or contained only a few lymphocytes. In 1 case a virus identical with herpes simplex was isolated from the brain.

III.—ENCEPHALITIS DUE TO VISCEROTROPIC VIRUSES.—Central or peripheral nervous lesions may occur as complications of infections probably due to viruses which are not primarily neurotropic but viscerotropic. Glandular fever, infective hepatitis and mumps are examples of this. Bernstein (1940) describes the nervous manifestations of infectious mononucleosis, the commonest of which is meningitis with a mononuclear pleocytosis of from 200 to 1,000 cells in the cerebrospinal fluid. Both in this disease and in mumps the nervous manifestations may be more prominent than the visceral and these infections probably account for some cases labelled "acute aseptic meningitis". Newman (1942) in the Lavant valley epidemic of infective hepatitis observed patients with mild cerebral, meningitic and neuritic symptoms. In a patient of mine unilateral convulsions and hemiplegia, together with mild polyneuritic signs, preceded the onset of the jaundice: recovery was complete.

IV.—ACUTE ASEPTIC MENINGITIS.—This is a useful term for a clinical picture with a very mixed aetiology, namely, a benign meningitis with a pleocytosis either lymphocytic or polymorphonuclear in the C.S.F., which is sterile on culture for bacteria. The virus of acute lymphocytic chorio-meningitis and its congeners probably account for only a minority of cases (Baird and Rivers, 1938). As already suggested some cases may be due to infectious mononucleosis or mumps; others to poliomyelitis without paralysis, others again to viruses not yet identified. Though the pleocytosis is usually mononuclear a similar clinical picture running a benign course is occasionally found in conjunction with a polymorphonuclear pleocytosis in a sterile cerebrospinal fluid, and in one such case the virus of lymphocytic choriomeningitis was isolated from the fluid. Drugs of the sulphanilamide group should be used for all cases of this kind.

V.—POST-EXANTHEMATOUS ENCEPHALITIS.—Little has been added to existing knowledge about encephalitis following vaccination, measles and other exanthems. Anderson and McKenzie (1942) state that in Glasgow in 1942 seven cases of postvaccinal encephalitis occurred among half a million people vaccinated, an incidence of 1:71,000. Two died, the remaining five completely recovered.

Measles encephalitis is certainly much commoner: I have seen 6 cases in the last two years. Complete recovery may occur from a condition which during the first weeks of the illness looks hopeless. For example, a girl aged 12, six weeks after the onset of encephalitis was mute and diplegic. Three months later she had almost completely recovered. It is difficult to assess the results of treatment, but it is advisable to use convalescent or immune horse serum.

VI.—NEUROLOGICAL SEQUELÆ OF INOCULATION WITH TOXOIDS OR KILLED BACTERIA.—(1) *Tetanus toxoid and T.A.B.*—I have seen 3 cases of nervous disorder following inoculation with tetanus toxoid with or without T.A.B., 2 in the acute phase. A man aged 24, eleven hours after his second or third injection of T.A.B. and tetanus toxoid developed headache, fever and dimness of vision. Two days later his cerebrospinal fluid contained 100 mg. of protein and a fortnight later 24 lymphocytes per c.mm. He was then recovering and showed no abnormal physical signs. Palmer (1941) has reported a fatal case of encephalitis developing shortly after one injection of tetanus toxoid and two of T.A.B. Focal hæmorrhages and thromboses were present in the brain. My second patient, a week after his third injection of tetanus toxoid developed fever, rash and swelling of joints and a severe radiculitis involving both upper limbs. Fifteen months later his recovery is almost complete. Since identical symptoms may occur after horse serum it is probable that the cause in this case was sensitization to the foreign protein. The cause of encephalitic symptoms is at present unknown.

(2) *Diphtheria toxoid.*—I have seen 4 cases of nervous disorder occurring within a few days of A.P.T. inoculation against diphtheria. One was the fatal case of encephalitis with inclusion bodies already described. The other three were all cases of poliomyelitis, occurring when this disease was already prevalent. The relationship of the infection to the inoculation is at present unsettled. Before deciding that there is such a relationship it is necessary to ascertain statistically that the incidence is higher among immunized children than in the community at risk. In any case it should be emphasized that with diphtheria immunizations numbering thousands and T.A.B. and tetanus toxoid inoculations numbering millions these complications are extremely rare.

VII.—SULPHANILAMIDE ENCEPHALOPATHY.—Finally it should be borne in mind that sulphanilamide may cause demyelinating lesions of the brain and spinal cord as Fisher and Gilmour (1939) have shown. Drugs of this group are now so widely used in the treatment of acute infections, that, as Henson and Russell (1942) have pointed out, we

should be cautious in attributing to the infection an encephalopathy which may be the result of the treatment.

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Dr. J. G. Greenfield first described the lesions found in Dr. Brain's case of subacute encephalitis with inclusion bodies in the nerve cells. The brain in this case was unusually firm in the fresh state, but otherwise did not appear abnormal. On microscopical examination the changes were of four main types: (1) degeneration of neurones, many of which contained inclusion bodies of the A type. The nerve cells most affected were those of the cortex especially in the Rolandic area and the hippocampus, the basal ganglia, the inferior olive and the anterior and posterior horns of the spinal cord. (2) Hypertrophy and increase in number of the microglial cells in the affected areas of grey matter. (3) Lymphocytic infiltration of the walls of vessels, which was present also in areas where neuronal degeneration was not seen. (4) Swelling of astrocytes and overgrowth of neuroglial fibres in the cortex, subcortical white matter and basal ganglia. A few inclusion bodies were seen also in the nuclei of oligodendroglial cells. This last observation placed the virus causing the disease in Weston Hurst's pantropic class, but no lesions could be seen in any other viscus than the brain.

Dr. Greenfield then described a case of acute encephalitis, fatal in six days, in which widespread and intense inflammatory changes were present in the cortex, brain-stem and spinal cord but sparing the hippocampus and cerebellum. He did not think that the case was one of encephalitis lethargica as the perivascular infiltration was of a mixed type, containing histiocytes and endothelial cells as well as lymphocytes, the degree of cortical inflammation was greater than was usual in encephalitis lethargica, and the neurones of the substantia nigra remained healthy although surrounded by inflammatory cells.

Dr. Brain had spoken of "post-exanthematous encephalomyelitis" but cases with exactly similar pathological lesions might follow at an interval of a few days acute diseases of the upper respiratory passages which in some cases resembled influenza, in others coryza.

Dr. Weston Hurst had recently described a condition to which he gave the name "acute hæmorrhagic leuco-encephalitis". Dr. Greenfield had examined a case of this kind and had been able to confirm Weston Hurst's observations. In this case there was an acute hæmorrhagic inflammation of the central part of the centrum semiovale, involving the corpus callosum in its middle third. The cortex overlying the most severely involved part of the white matter showed some invasion by polymorphonuclear cells and endothelial proliferation in the small vessels, and a few polymorphonuclear cells were also seen round a small vessel in the pons. But for the most part the lesions were limited to the white matter. He considered that this disease was more likely to be due to bacterial toxins than to a virus.

Dr. Dorothy Russell: The pathological material examined by me during the past few years includes but few examples of encephalitis. Amongst them, however, are two forms, apparently newcomers in this country, which have already been described by the previous speakers.

The first of these is an example of the "inclusion encephalitis" of Dawson (1934). It is essentially similar to the case described by Dr. Russell Brain and Dr. Greenfield, and to the three already reported from America (Dawson, 2 cases; Akelaitis and Zeldis, 1942, 1 case).

*Clinical and post-mortem findings* (Dr. E. O'Flynn).—Boy of 4 years, admitted September 4, 1939. Gradual onset of weakness of all four limbs.

On examination the child was unable to stand or sit up. Speech was indistinct. Periods of irritability alternated with lethargy, but intelligence was not impaired. The cranial nerves were normal. There was flaccidity and diminished power in the arms; the legs were spastic.

All reflexes were present in the limbs, being brisk in the legs. The plantar reflexes were flexor. No sensory changes could be elicited from lack of co-operation.

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JOINT DISCUSSION No. 3

# Sections of Surgery and Urology

Chairman—E. C. HUGHES, O.B.E., M.Ch.

(President of the Section of Surgery)

[February 3, 1943]

## DISCUSSION ON NON-SPECIFIC EPIDIDYMITIS

Mr. E. G. Slesinger (who opened the discussion) pointed out that non-tubercular, non-gonococcal epididymitis is far commoner than the textbooks would lead one to believe, and that the incidence in Service personnel in this war is particularly high. He gave details of 34 cases seen at Preston Hall E.M.S. Hospital, of which 11 were bilateral and 6 recurrent. The onset in almost all the cases was sudden, with pain and swelling the presenting symptoms, and in all the cases the whole epididymis was enlarged, hard and tender. In these 34 cases the vas was thickened in 16, and the vesicle in 12. In only 12 cases did the urine show any abnormality, and then only the presence of a little albumin and a few pus cells. The opener stressed the similarity of many of these cases to tuberculosis, and feared that patients were being needlessly submitted to operation under a mistaken diagnosis. Unless there was definite evidence of tuberculosis elsewhere, every case of epididymitis should be treated conservatively in the first place; with rest and local heat cases of non-specific epididymitis would resolve. There was one group which would get well in three weeks, but another which might take as many months; administration of the sulphonamide drugs did not appear to affect the course materially. He gave reasons for his belief that in every case of epididymitis the pathway of invasion was the lumen of the vas, and the vas alone, as was suggested by Wells in the case of tuberculosis. This was readily understandable in that group of cases which are secondary to infection in the urine, either from some abnormal condition in the urinary tract, or from a non-gonococcal posterior urethritis, but in the group of cases with no urinary change the explanation was not so obvious. This was the group that he believed showed the unusual incidence in this war, and on which he hoped the discussion would particularly throw light. He believed that this type of case was due to the passage of sterile urine down the vas. The frequent history of a "strain", or of physical training exercises as the alleged cause, the sudden onset, and the immediate involvement of the whole epididymis, together with the fact that suppuration never occurred in this group, appeared to support this view, while many observers had reported that backflow of urine down the vas could and did in fact occur. He would be interested to know the views of other members on this hypothesis, and suggested as one experimental prophylactic measure the compulsory emptying of the bladder before P.T. exercises.

Mr. Donald McGavin (*Summary*): An epididymitis exists which is distinct from tuberculosis, gonorrhoea, obvious urinary infection or instrumentation of the urethra.

If, in the chronic phase, this is diagnosed as tuberculous, it commonly receives too gloomy a prognosis and unnecessarily drastic treatment. Failure to recognize such an entity as distinct from tuberculosis leads to too optimistic a prognosis of tuberculous epididymitis and of certain forms of treatment, as well as an under-estimate of the frequent association of genital and urinary tuberculosis.

This non-specific disease of the epididymis falls into three sub-groups: Inflammatory, obstructive and vascular. The obstructive and vascular groups are small and occur in

*Lumbar puncture* September 5: C.S.F. normal.

*Course*.—There was occasional pyrexia up to 100° F. Ataxy of the arms was noted two days after admission. Spasticity increased, accompanied by extensor plantar responses, and difficulty in swallowing, especially fluids. Blindness developed a few days before death, which took place in hyperpyrexia (106° F.) on October 6, 1939, eleven weeks from the onset of the illness.

*Post-mortem examination* (twenty-four hours later): The brain appeared full and firm; heavier than normal (1,441 g.). On section the cerebral hemispheres were of normal appearance but the white matter felt somewhat rubbery. The spinal cord was not examined.

*Histology* (Dr. Dorothy Russell).—(1) Focal cuffing of the perforating vessels with lymphocytes and plasma cells, affecting both arteries and veins. Little evidence of meningitis; (2) severe but somewhat focal degeneration and necrosis of cortical neurones associated with eosinophil intranuclear inclusion bodies of Cowdry's Type A. Hyaline eosinophil masses are also present in the cytoplasm of the affected neurones; (3) accompanying this degeneration is a brisk microglial proliferation with formation of rod-cells; (4) proliferation of astrocytes in the deeper layers of the cortex and in the subcortical white matter; (5) little change save focal perivascular cuffing is found at lower levels in the brain.

Inclusion bodies were not found in astrocytes but were occasionally observed within the nuclei of oligodendroglial cells. This was also noted by Akelaitis and Zeldis 'who pointed out that it rendered untenable the theory of Levaditi that demyelination is caused by oligodendrocytropic viruses—since no foci of demyelination are present in any of these recorded cases.'

This is an encephalitis with the hall-marks of a virus infection, in which the main brunt is suffered by the pyramidal cells of the cortex. The absence of demyelination brings into focus the view, held by many, that other aetiological agents should be sought in explanation of the demyelinating forms of encephalomyelitis. The inclusion bodies bear a close family likeness to those of herpes simplex, but until transmission to laboratory animals has been effected the significance of the resemblance remains obscure. That the infection is not in fact herpetic is suggested by Dawson's failure to transmit the disease to a variety of animals.

The second condition to which I should like to refer is the "acute hæmorrhagic leuco-encephalitis" described in Australia by Weston Hurst (1941). I have seen two cases the first of which has already been reported (Henson and Russell, 1942). The second occurred about a year ago at the London Hospital and material was kindly sent by Professor H. M. Turnbull. Recapitulating Hurst's records and those at my disposal, this disease seems to be of sudden onset with a rapidly fatal course. No clear evidence of any aetiological factor has emerged from the histories. In my published case there had been a febrile attack, diagnosed as coryza, twelve days before the onset of the encephalitis and separated from it by a period of recovery lasting five days. In one of Hurst's two verified cases there had been an attack of pharyngitis about three weeks before the encephalitis, but the significance of these earlier indispositions is questionable. The encephalitis is characterized by the sudden onset of hemiplegic symptoms, progressing to a quadriplegia and accompanied by coma, pyrexia and leucocytosis. The C.S.F. shows no obvious departure from normal, but may be under increased pressure. Dr. Greenfield, however, noted an excess of polymorphonuclear leucocytes in his case; in this connexion it is of interest that in Hurst's first case, in which no examination of the C.S.F. was made, there was considerable focal infiltration of the leptomeninges with these leucocytes.

Dr. Greenfield has given a description of the pathological appearances in this type of encephalitis. In my two cases the findings were essentially similar. The uniformity displayed seems to indicate that this is a special form of encephalitis. Yet some relationship may well exist between this acute hæmorrhagic leuco-encephalitis and brain purpura on the one hand, and the disseminated demyelinating forms of encephalitis on the other. It stands as a connecting link between the two extremes. Support for this view is provided by the occasional finding of non-hæmorrhagic foci of demyelination in conditions that are more characteristically manifested as brain purpura, such as arsphenamine intoxication and cerebral fat-embolism (Greenfield, 1941). The possibility of a biochemical basis in the demyelinating forms is indicated by such observations, and again by Hurst's experimental production of disseminated subcortical foci of demyelination in monkeys by chronic cyanide poisoning. The mechanism here appears to be that of a histotoxic anoxia. In fat-embolism another form of anoxæmia is witnessed.

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and bilateral lesions or abscess formation both point to the latter diagnosis. In some cases an expectant attitude may be the only means of establishing the cause, and in the absence of any positive evidence of tuberculosis, no harm can accrue from this. Certain vascular lesions may give rise to difficulty, such as thrombosis in a varicocele or thrombo-angiitis obliterans of the epididymal vessels.

*Treatment.*—This should be expectant in the majority of cases, a suspensory bandage and counter-irritants being given. In the more acute forms, rest in bed and, if necessary, incision of abscess, will be required. In chronic cases, where pain and disability persist, epididymectomy is indicated and is usually feasible in preference to orchidectomy. In recurring cases, vasotomy may produce a cure.

At St. Thomas's Hospital in the years 1933-39 inclusive, there were 176 cases of epididymitis, and 90 of these were non-specific in type. I have to thank my surgical colleagues for their assistance over these figures.

In a series of cases under my own care at St. Thomas's Hospital, during the years 1933-39, there were 50 cases of epididymitis admitted to the surgical unit. Of these, 24—or approximately half—were non-specific, the remaining 26 being either tuberculous (23) or gonococcal (3).

At Botleys Park Hospital, in 1941 and 1942, 21 cases of epididymitis were admitted, and of these 19 were non-specific—rather a surprising figure.

If we amalgamate these two groups, we obtain 43 cases of non-specific epididymitis. Of these 25 were on the left side, 16 on the right, and only two bilateral. It will be remembered the tuberculous disease is bilateral in 50% of cases, and is stated to be commoner on the right side.

The age-incidence was as follows: Under 20, 1 case; under 30, 16 cases; under 40, 11 cases; and over 40, 15 cases.

Turning to aetiology, the following facts were elicited: Onset followed a chill in 3 cases; trauma in 1; and dental sepsis in 1; no obvious cause being discovered in the remainder. In 10 cases, *B. coli* was found in the urine, and in 11 sterile pyuria was present. In other words, half the cases were associated with definite pathological findings in the urine. Curiously enough, only 9 patients complained of any urinary symptoms, the symptom being hæmaturia in 2 cases. In 1 case there was an associated *B. coli* pyelitis. In one case a sinus formed in the postero-inferior surface of the scrotum, but no evidence of tuberculosis could be discovered. In 3 cases orchidectomy was carried out, as the diagnosis had been considered to be tuberculosis, but microscopy revealed no evidence of this.

In the cases treated conservatively, the time taken for resolution varied from a few weeks to six months. Five cases were recurrent, the longest interval between attacks being twelve years. One of the patients suffering from bilateral disease had had one testicle removed elsewhere two years before admission. 12 patients were serving soldiers, and of these 2 had to be boarded out of the Army for the condition. I have not included any cases developing after instrumentation or operation on the urinary tract.

*To summarize.*—The condition is a common one, likely to be confused with tuberculosis, liable to relapse, and sometimes requiring operative interference to relieve the pain and disability.

**Wing Commander J. C. Ainsworth-Davis:** 58 cases of non-specific epididymitis have been treated at a R.A.F. General Hospital during the past twenty-one months. I have divided them into two types: (a) epididymitis secondary to disease of either the urinary or the genital organs, and (b) epididymitis which is primary as far as the urinary and male genital tracts are concerned.

(a) In my series there were 21 cases of secondary epididymitis. The urinary causes for these include (1) chronic posterior urethritis, which may be secondary to urethral stricture, peri-urethral disease, or to hypertrophy of the verumontanum, and (2) cystitis, which may either be primary or secondary to prostatic obstruction, to a vesical calculus or growth, or to upper urinary infection. The genital causes are due either to prostatitis with or without calculus formation or to vesiculitis. The epididymitis may occur spontaneously or be brought on by prostatic massage, passage of instruments such as catheters or bougies, or by operations on the prostate or urethra.

(b) The other variety of epididymitis, of which there were 37 cases, is primary as far as the urinary and male genital tracts are concerned, and appears to be a blood-borne infection

older subjects; they have been described in another paper (*Brit. J. Surg.*, 1939, 26, 800). The inflammatory group is the most numerous and important, and is the one discussed below.

The condition occurs in younger men (24 to 38 in this series), without obvious predilection for the right or left side, and is often bilateral. In bilateral cases the onset on the two sides may be simultaneous or may be separated by an interval (four to twelve weeks). The onset may be chronic, subacute or acute. The duration, when first seen, averaged six weeks (two days to twenty-four weeks).

Possible exciting factors need to be considered. The most obvious suggestion is an infection from the urine or internal genitalia, carried either along the lumen of the vas or perhaps along the lymphatics. The blood-stream can hardly be considered as a source of infection in this condition. But more than half the cases in this series had no evidence of infection whatever, and three associated the onset with a definite strain; in one case recurrent attacks followed recurrent exertions with difficulty, pain and a spurt of blood on starting micturition. It is suggested that in at least some of the cases the cause is a sudden strain leading to sterile urine being forced back along the vas to irritate the epididymis and so cause an inflammatory reaction. Two conditions previously described as clinical entities may really belong to this group: "Epididymo-orchitis of strain" and tuberculous epididymitis with acute onset, settling down to a chronic course.

The course in nearly all cases was towards resolution, complete or with a small residual nodule in the lower pole, in periods of three to twenty-eight weeks. Atrophy of the testis was not seen.

Full investigation should be carried out to exclude infections of the urinary and genital tracts, particularly tuberculosis. Treatment involves rest in the early stage, followed by modified activity with a suspensory bandage. The patient should be under frequent observation. Should there be any urinary infection this should be given the appropriate treatment. Operation is only indicated for positive evidence of tuberculosis, suspicion of neoplasm, abscesses or a progressive local condition. If operation becomes necessary epididymectomy, whenever possible, is better than orchidectomy.

**Mr. R. H. O. B. Robinson:** In our definition of epididymitis we mean epididymo-orchitis, in which the accent is on the epididymis and unassociated with tuberculosis, syphilis or gonorrhœa present or past. It varies in acuity, being either ushered in with dramatic suddenness and considerable constitutional disturbance, or else developing insidiously. In the more chronic cases, one part of the epididymis—either globus major or minor—may be affected in particular. An associated hydrocele is often found, while funiculitis and actual beading of the vas may occur. Suppuration may take place. The time taken for resolution is extremely variable, some cases lasting for months, and there is a definite tendency to relapse.

Although the condition may be bilateral, it is as a rule on one side only, in contrast to tuberculous infections. Microscopic studies of specimens removed at operation show acute and chronic inflammation, occasionally with abscess formation, while the tubular epithelium is degenerate.

**Ætiology.**—In many cases no definite cause can be determined, but possibilities are infection, trauma, and congestion.

Infection may come from the urinary tract or posterior urethra, as is the case in gonorrhœa. Non-specific urethritis and prostatitis may be responsible. In other cases the infection is metastatic, being due to influenza, meningitis, or typhoid. Occasionally active infection in the upper urinary tract occurs concurrently. Congestive cases may be seen as in erotic epididymitis. Some cases appear to result from mild trauma or over-exertion, and it has been suggested by American authors that the forcing of sterile urine past the internal sphincter into the posterior urethra during violent exercise may be responsible.

The organism most commonly isolated is the *Bacillus coli*; less frequently, staphylococcus and streptococcus. In many cases sterile pus is found in the urine, the causative organisms having presumably died out. In this group, exhaustive tests fail to reveal any evidence of tuberculosis.

**Diagnosis.**—The acute forms have to be differentiated from gonorrhœal epididymitis. In more chronic forms, the principal differential diagnosis is from tuberculosis. A definite history of tuberculosis, or the presence of other tuberculous lesions, is pathognomonic.

## Section of Orthopædics

President—B. H. BURNS, F.R.C.S.

[February 2, 1943]

### The Emancipation of Orthopædic Surgery

By ROYAL WHITMAN, M.D. Harvard, Hon. F.R.C.S., New York

It was in the year 1841 that the term Orthopædic Surgery first appeared in a book by Valentine Mott. He defined it as the combination of Mechanical and Operative Surgery "which had inaugurated a new era in the healing art". The surgery that he had in mind, was the subcutaneous division of contracted tissues, and the "meridian splendour" of the new era, which he envisaged was postponed for many years.

During this prolonged anticipatory period, the treatment of deformity and deforming disease was still considered the special province of the mechanicians and the amalgamation with surgery was accomplished only after a bitter controversy, that lasted throughout the century.

The storm centre was New York where, according to a contemporary writer "All or nearly all the advance in the use of modern methods of caring for the deformed poor may be ascribed to the influence of four great men": James Knight, Charles Fayette Taylor, Henry G. Davis, and Lewis A. Sayre.

Sayre was a surgeon, the first professor of orthopædic surgery and the author of the first book under this title. He regarded it as a branch of surgery and included diseases of the joints, fractures, dislocations, and clinical surgery as within his professorial jurisdiction.

The three others, although at odds with one another were united in their opposition to Sayre and to all that he represented. Davis practised what he called conservative surgery, defined by a quotation from Hippocrates "As a Mode of Cure and it requires neither cutting nor burning nor any other complex means". He originated the "American treatment of hip disease" by "continued elastic extension" which, by permitting motion without friction, conserved the function of the diseased joint.

Taylor "never wrote a prescription" nor performed a surgical operation. His original interest was in physical culture. For a time he conducted a gymnasium and invented many machines for passive exercise.

An unfortunate experience in the treatment of Pott's disease by such means turned his attention to "protection" and led to the invention of the "spinal assistant".

The spinal assistant was provided with "two hinges, allowing the instrument to bend backward but not forward, in order to allow the muscles to act when they wanted to protect the affected vertebræ completely in case the muscles should tire and relax". Thus the spinal assistant, in combining voluntary motion with protection conformed in principle to Davis' motion without friction, and in this particular, Sayre was also in accord with Davis.

Knight was an ultra-conservative, who rejected all the advances in modern methods credited to his colleagues in favour of "expectant" or constitutional treatment of chronic joint disease. This required a constant personal supervision, practicable only in a hospital under single control. "With this impression we introduced the initiatory efforts in our own dwelling" under the title of the Hospital for the Relief of the Ruptured and Crippled.

The essentials of the expectant treatment were "enforced hygiene, regular and nutritious dietary, tonic remedies, and above all bodily activity. No child able to hold up its head is ever kept in bed during the day and all able to walk by pushing a chair in front of them have thus to exercise".

Knight practised what he called surgico-mechanics, to which his distinctive contribution was a truss: thus rupture took precedence in the hospital title.

Knight's "initiatory efforts" fulfilled all his expectations, for he was able to report that "75% of the variously conditioned patients, labouring under synovitic disease were restored to self-sustaining ability".

Within a few years a model building was constructed under his personal supervision. The city paid for the maintenance of the children and provided teachers for their "religious and secular instruction". The treatment was conducted by Knight and a resident assistant. The mechanical supports were home-made, inexpensive and "available to the poorest in the community". Thus since the hospital was self-contained and



coming from such sources as the colon; a distant focus of infection; possibly following inoculation; and, rarely, following an injury. Those from the colon are probably *B. coli* infections occurring idiopathically in individuals who are run down from overwork, and in whom there is no obvious focus of infection. When an obvious focus is present, such as boils, carbuncles, tonsillitis or septic teeth, the epididymitis is probably staphylococcal. It is known that epididymitis can occur during the course of a fever such as typhoid and paratyphoid, and it is possible that inoculation against these diseases may be a causal factor in a variable number of cases. In four cases of the series there was a history of trauma which may have been the exciting factor.

The attack begins with pain in the groin and lower abdomen, and is soon followed by pain and swelling of one side of the scrotum. There is usually some fever, and the patient looks and feels ill. The scrotum is red and oedematous and is often adherent to the epididymis behind and below. The whole epididymis is swollen and very tender. The testis is difficult to palpate because of the pain, but is of normal size. A small degree of hydrocele is present. The cord is swollen, hard, tender, and it is difficult to feel the vas. The attack reaches its height about the fifth day and gradually subsides in about ten days, leaving some thickening of the globus minor, which is tender on palpation. Suppuration never occurs.

*Diagnosis* is made from secondary non-specific epididymitis and from tuberculosis by the absence of disease in the prostate and vesicles, and by the normality of the urine; and from gonococcal epididymis by the history, the absence of urinary infection and of the other signs of gonorrhoea.

*Treatment.*—Absolute rest in bed, with the scrotum surrounded by antiphlogistine, resting on a piece of elastoplast, stretched across the thighs. A good aperient is given followed by a saline in the morning, and the latter continued every morning. Morphine is often necessary for pain, and later replaced by empirin compound. Two tablets (1 g.) of sulphathiazole are given t.d.s. for five days, and the urine examined again at the end of this time. Acupuncture and decapsulation of the epididymis have not been found to be necessary. About the tenth day, the patient is allowed up with a well-fitting suspensory bandage and a short-wave diathermy is given daily in the massage department. All patients are seen a month after discharge to full duty in the urological out-patient department (i.e. about two months after the beginning of the attack) when slight painless thickening of the epididymis is all that remains of the disability.

**Wing Commander G. L. M. McElligott:** Primary non-gonococcal urethritis is a common condition and between 30 and 40% of all cases of urethritis treated at Service venereal diseases centres are of this type. The condition is usually not severe, sometimes escapes the patient's observation, and, except in the comparatively rare cases where it is due to an infection with coliform organisms, is not affected by sulphonamide chemotherapy.

Since the sulphonamide era, gonococcal epididymitis is uncommon and the few cases of epididymitis I now see more often than not follow a non-gonococcal infection of the urethra. I feel that these infections are usually venereal and that they may be acquired from a consort, whose previous gonococcal cervicitis has been successfully treated with sulphonamides, but in whom the almost invariable secondary infection has not been cured.

It is noteworthy that pus cells were found in the urine in 12 of Mr. Slesinger's cases and I feel that had morning specimens been examined, "threads" and pus would have been found in most of them. It is well known that the urethral discharge often temporarily ceases on the onset of an epididymitis.

Non-gonococcal epididymitis is usually unaffected by sulphonamides, rest and heat in the form of diathermy or short-wave therapy giving the best results. The condition not infrequently relapses and a residual node almost always remains in the lower pole of the epididymis.

I recently saw a case of epididymitis without any urinary findings which developed a specific parotitis within a few days. I have noticed that contrary to the classical teaching, the epididymis is often as much enlarged in these cases as is the body of the testis.

by initial efficiency in providing the opportunity for repair, supplemented by an equally efficient after-treatment which is the determining factor of the result.

As evidence of the advantage of these qualifications it may be noted that the effective treatment of the most recalcitrant examples of fractures and dislocations, that of the femoral neck and congenital misplacement at the hip, the salvaging of functional derelicts by reconstructive surgery and the prevention of disability by the recognition and timely treatment of many of its predisposing causes must be credited to the Era of Emancipation.

From this review it should appear that the emancipation of orthopædic surgery was coincident with the establishment of operative surgery as the dominant factor in its title.

It transformed an ill-found and static speciality to an important and progressive branch of surgery. As this transition or recreation has been accomplished during my professional lifetime, I might say in the words of another: "These things I saw and a part of them I was."

## Spinal Arthritis and Sciatica

By A. S. BLUNDELL BANKART, M.Ch.

THE symptoms and signs of spinal arthritis are well known and not easily mistaken. But when a patient with the same symptoms complains of pain in the course of the sciatic nerve the diagnosis most usually made is not spinal arthritis; the symptoms are attributed to the effect of an inflamed peripheral nerve on the muscles and ligaments of the back.

It is no mere coincidence that both spinal arthritis and sciatica are common in middle-aged and elderly people, nor is it just a chance that younger patients with traumatic arthritis of the spine may also suffer from sciatica. The majority of patients with sciatica seen in orthopædic practice have symptoms and signs of spinal arthritis, and I believe that this is by far the commonest cause of sciatica.

Severe osteoarthritis of the spine may occur without sciatica. Again in many cases there may be no radiological evidence of spinal arthritis.

It has been said that the intervertebral foramina are so large that osteophytic outgrowths from the lateral joints could not possibly press upon the spinal nerves. But no one has ever suggested that they do. Actually osteophytes rarely occur in this situation.

Osteoarthritis is not simply an affair of osteophytes and gross X-ray changes. In many situations, notably in the shoulder-joint and sometimes in the knee, well-marked osteoarthritis occurs without gross X-ray changes. The same is true of the lateral joints of the spine, although in most cases some hint of it can be found in the X-rays. Osteoarthritis produces both an intraarticular and a periarticular reaction, and it is this periarticular inflammatory reaction which in many cases involves the spinal nerves in the intervertebral foramina.

Though I think it probable that all sciatica is due to neuritis, I do not agree that the long nerve fibres which run all the way from the spinal cord to the terminations of the great sciatic nerve can be irritated or inflamed in only one particular part of their course, i.e. in the thigh. I have no doubt that the sciatica of spinal arthritis is due to neuritis and it gives rise to the symptoms and signs of neuritis.

Sicard's conception of "neurodociitis" or "funiculitis", provides at any rate a working hypothesis on the causation of spinal arthritis which can be judged by results.

For many years I have treated spinal arthritis and sciatica by manipulation followed by radiant heat, massage, and exercises, in the belief that the same periarticular inflammatory reaction which causes the stiffness of the spine is also responsible for the sciatica. Sometimes I have given epidural or paravertebral injections as well, but I have not been impressed with their value. About half the cases are cured at the time, but some of these get recurrences of the sciatica later on.

In persistent or recurrent cases I have not hesitated to remove the corresponding lateral intervertebral joints. Putti called this "decompression of the intervertebral foramina", but he never suggested that these joints or outgrowths from them were pressing on the spinal nerves. Decompression effects a relief of tension, and that is good for any inflamed tissue, whether it be an abscess or an inflamed nerve in a bony canal. This operation rarely, if ever, fails to cure the sciatica. I have operated upon a large number of selected cases during the last fifteen years and to me at any rate it is a comfort to know that one can cure sciatica when one wants to.

Spinal arthritis is the commonest cause of sciatica; most cases respond to simple treatment, such as radiant heat, massage, and exercises, with or without preliminary

self-sufficient no change from the established routine was desired or permitted during the lifetime of the founder.

Yet Knight, the static passivist, indirectly and unwittingly made a more important contribution to future progress than any of his militant colleagues. For his liberal interpretation of the scope of surgico-mechanics, which included every disability that might be relieved by bandaging or bracing, irrespective of the sex or age of the patient, provided the clinical material for future development on a broad scale.

When I joined the staff in 1889 the hospital was still essentially a home for the relief of crippled children, but Knight's successor Gibney, had improvised an operating room and in succeeding years surgery steadily encroached upon expectancy until it became eventually, the dominant factor in the treatment of both the ruptured and the crippled. In Gibney's first report, there were but 237 operations, 162 of which were subcutaneous tenotomies and most of the others were for the complications of tuberculous disease.

In 1929 there were 1,875 orthopædic operations and 1,647 for hernia.

Thus, for the ruptured, radical cure had supplanted the truss and for the crippled, reconstructive surgery, implying the readjustment of the statics and mechanics of the disabled member had greatly extended the operative range. Although the mechanical factor in orthopædic surgery had been relegated to a subordinate position, its efficiency had been greatly increased, since it was applied with a definite and attainable purpose, often as an adjunct or supplement to operative intervention. Yet although the operations practically equalled in number the admissions to the hospital they involved only a relatively small proportion of the patients under treatment—for there had been a great development of the non-operative service. In 1929 for example, more than 5,000 new cases of the so-called flatfoot were recorded. Thus a disability unnoted in Knight's reports nor, from a remedial standpoint, in surgical literature had become numerically the most important constituent of the outdoor clinic.

If the experience of this hospital be accepted as fairly representing a natural development under the vivifying influence of operative surgery—the most important step toward emancipation from hampering restrictions was the organization of the American Orthopædic Association in 1887.

It was designed to promote mutual toleration of the conservative and progressive factions, in order to qualify, as a speciality for admission to the Congress of Physicians and Surgeons, to be held the following year. At this meeting, the president of the Association was an aggressive upholder of the exclusive practice of mechanico-therapeutics, who permitted no surgery in the hospital that he controlled. He represented the prevailing conception formulated by the *American Textbook of Surgery*: "That Orthopædic Surgery has properly to do with deformities and Contractions especially by some form or other of Mechanical appliance."

This definition, made in 1896 actually marked the passing of the old era, for it had already become apparent that the progressive element in the Association was in the ascendant and that orthopædic surgery had outgrown the restrictions that had once qualified it as a speciality, as well as the conditions to which it was adapted.

In Knight's first report of his hospital, 101 of the 253 orthopædic cases were of "synovitic disease". As late as 1916 more than 600 new cases of tuberculosis of the joints were registered and 35% of the ward cases were of this nature. In 1929 the total had fallen to 80 and the proportion in the wards to less than 3%.

"The advances in modern methods of treatment" of this disease credited to the group of great men have not stood the test of time. Davis' elastic extension, "which had revolutionized the treatment of bone and joint disease" has been discredited and forgotten. Taylor became the master mechanic of the group but the inspired "spinal assistant", which combined motion with protection, soon lapsed into a rigid support.

Knight's truss has been discarded and even the name of the hospital has been changed to conform to the "adventurous" treatment which he deplored. Sayre's "peculiar" views on pathology and treatment have been outmoded and of his numerous contributions to mechanical and operative surgery only the plaster jacket is identified with his name. He has qualified as the "forerunner of orthopædic surgery", not because of the soundness of his theories but because of his rejection of the restrictions, of scope and method, which the term orthopædic had always implied.

Now that his contention has been generally accepted the term indicates only a field of action, primarily concerned with impairment of bodily structure and mechanism from any cause. This is a broad, ill-defined and constantly expanding territory to which the orthopædic surgeon has no preferential claim other than the aptitude and preparedness which may be assured by a training in mechanical, manipulative and operative surgery, and a definite plan of campaign: Namely, to restore useful function,

This rough diagram (fig. 3a) indicates the fact that the fibula lies in a groove behind, as well as external to, the tibia; so that on an X-ray the shadow of the anterior lip of the groove on the tibia overlaps the fibula. This overlap was the diagnostic sign on which Ashurst placed the most reliance. These tracings of two X-rays of the same normal ankle, taken with slightly varying rotation of the leg, show how widely the shadow varies (figs. 3b and 3c). The considerable overlap (3c) is with external rotation of the leg and the

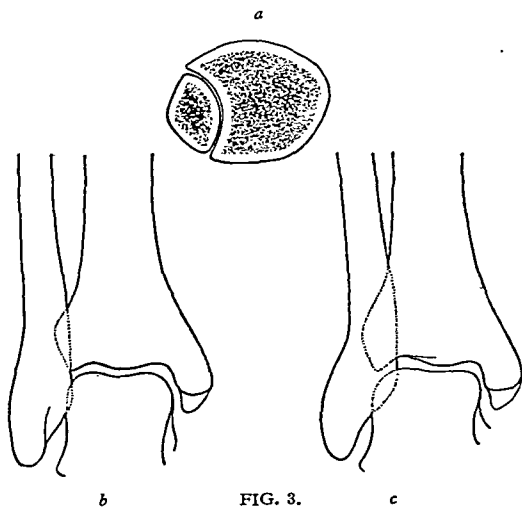


FIG. 3.

small amount of overlap (3b) is with internal rotation. Thus, in my opinion, the sign is unreliable.

In fig. 4, A indicates the overlap which is diminished. This is Ashurst's sign. In my opinion a more useful sign is the shift of the astragalus away from the internal malleolus

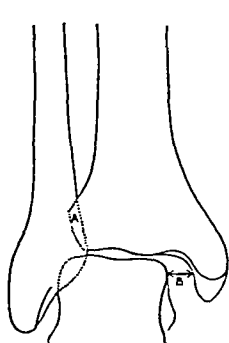


FIG. 4.

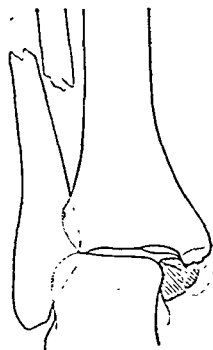


FIG. 5.

—B, with no fracture of the external malleolus. This shift of the astragalus without fracture of the external malleolus can only be possible with rupture of the inferior tibio-fibular ligament.

Fig. 4 is a tracing of an X-ray showing diastasis without fracture of the fibula. X-rays were shown of reduction which was maintained for three months in plaster, and of recurrence after removal of plaster. Subsequently fixation was done by bolt. The operation was necessary on account of pain and œdema on walking.

A possible difficulty in diagnosis is where there has been a fracture with lateral displacement of the internal malleolus (fig. 5); but if you do a mental replacement of the malleolus the diastasis is apparent. In this case also re-displacement recurred after three months in plaster. Further reduction was retained by a bolt.

Following is an instance of diastasis occurring with an external rotation fracture. First let me recall the displacement in an ordinary external rotation fracture (fig. 6a). Here the displacement of the astragalus from the internal malleolus corresponds with

manipulation with the object of mobilizing the lumbar spine; persistent or recurring cases can be cured almost certainly by spinal arthroectomy.

This operation appears to be little known or at any rate seldom performed by other surgeons. There are many patients undergoing prolonged and expensive treatment for the temporary relief of sciatica, and it seems a pity that suitable cases should not be given the prompt and permanent relief that surgery can offer them.

## Diastasis of the Inferior Tibio-fibular Joint

By B. H. BURNS, F.R.C.S.

Most ankle fractures give no trouble in treatment, but when trouble does arise it is usually with abduction fractures. Perkins says: "The external rotation fracture is a *pleasant* fracture: reduction is easy, secondary malunion does not occur, and only six weeks' splintage is required. The abduction fracture is an *unpleasant* fracture: reduction is difficult, secondary malunion is common, and splintage has to be continued for six months." But he gives no explanation for this. And the explanation has only lately, I think, been appreciated. It is the fact that in this fracture there is always a rupture of the inferior tibio-fibular ligament, and this ligament is very slow in healing. Thus the reduction is unstable and displacement often occurs.

Fig. 1 shows a Dupuytren, an extreme example of the abduction fracture. To recall the mechanism, there is a lateral thrust or push on the foot, mostly on the heel. The astragalus violently impinges on the malleolus, which is forced laterally, causing a rupture of the inferior tibio-fibular ligament, with diastasis or widening of the joint. The whole momentum of the body is then taken by the fibula, which breaks at about 3 to 4 in. from its lower end, at the lower end of the very strong interosseous ligament. There is also a rupture of the internal lateral ligament or a fracture of the internal malleolus. A point worth noting is that in all ankle fractures the astragalus remains closely attached to the external malleolus owing to the strength of the posterior ligament which joins the two together.

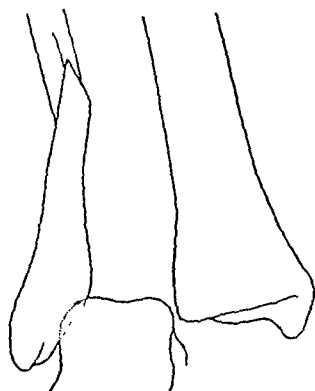


FIG. 1.

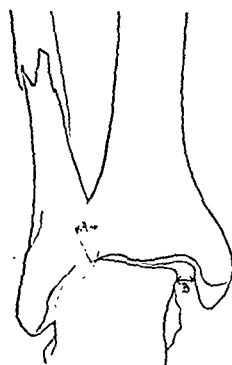


FIG. 2.

X-rays of two examples of wide abduction fractures were shown. In one reduction was maintained for four months. X-ray at eight months showed re-displacement, making arthrodesis necessary.

In the second, with accompanying fracture of the internal malleolus, perfect reduction was maintained for three months. X-ray at four months showed re-displacement with non-union of the internal malleolus.

With lesser degrees of abduction fracture also, the important feature is the rupture of the inferior tibio-fibular ligament and diastasis.

Patient injured his ankle in November 1935. Fig. 2 is a tracing of the X-ray. Notice the lateral shift of the astragalus. Reduction was maintained in plaster for three months. A few days after removal of the plaster displacement recurred. At this stage operation was advised but was declined. X-rays showed that the displacement was easily reduced again. Plaster was applied for a further three months. A few days after removal of plaster displacement recurred though not quite to the original extent.

The recognition of these minor degrees of diastasis is not always easy. Let us examine an X-ray of a normal ankle.

## Modified Subtaloid Arthrodesis

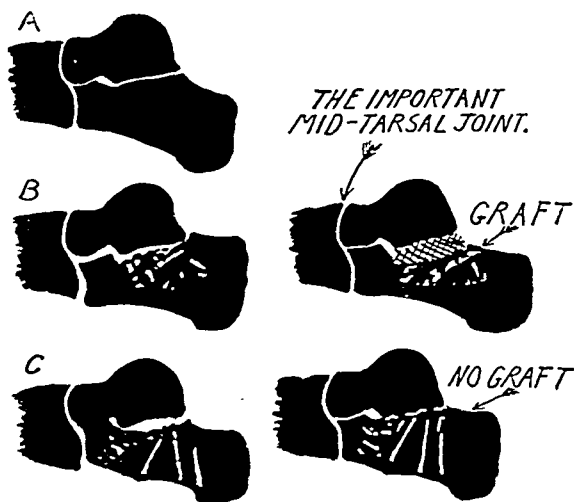
By W. SAYLE CREER, F.R.C.S.

THE subject of crush fractures of the calcaneus is topical because, so I am informed, many of our seamen are suffering from such fractures. But whereas in peacetime it was the man who fell down and hit the ground these men are injured by the ground, the deck of the ship, rising up to hit them, so to speak, because of submarine explosions of various kinds.

When it proves necessary to arthrodesis the subtaloid joint in these cases it is usual to perform a triple arthrodesis. Such an extensive obliteration is necessary when the mid-tarsal joint surfaces are involved in addition to the talo-calcaneal. But the ankle, subtaloid and mid-tarsal joints together form a compound joint equivalent to the engineer's universal joint. It is true that each portion of it is capable of separate movement but in point of fact every portion is utilized every time we move the foot on the leg or the leg on the foot. To excise two-thirds of the joint as is done by the triple arthrodesis operation is not sound orthopædic surgery if only one-third is damaged. If the integrity of the mid-tarsal joint is respected the patient is left with a much more mobile and useful foot.

It is quite obvious why surgeons include the mid-tarsal joint in their operation even when there is no reason for touching it. To obliterate the whole of the subtaloid joint it is necessary to open the mid-tarsal joint and that is the first breach of its integrity. Secondly, excision of the whole subtaloid joint results in a movement together of the head of the talus and of the anterior end of the calcaneus with a consequent alteration of the relative positions of the calcaneal and cuboid joint surfaces. A normal X-ray shows that the mid-tarsal joint is a slight S-curve, the articular surfaces fitting together with geometrical perfection (A). Excision of the whole subtaloid joint alters the coaptation in a manner similar to a fracture of the calcaneus with upward tilting of the anterior end (C) and results in secondary traumatic arthritis and pain in the mid-tarsal joint. This later pain is the reason why triple arthrodesis is generally performed.

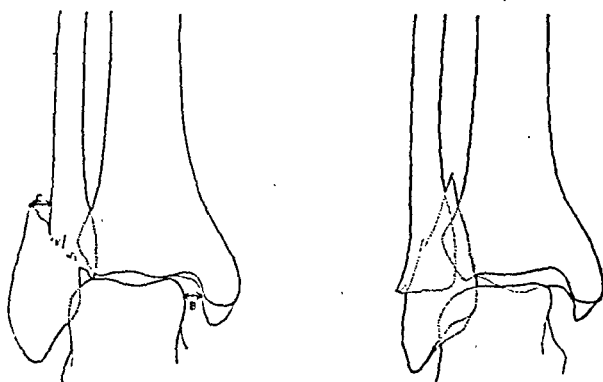
It can be avoided by arthrodesing only the posterior half of the subtaloid joint, which will stiffen it just as effectively as if the whole joint were excised, but will not alter the coaptation of the mid-tarsal joint surfaces provided we take certain simple precautions.



Furthermore by this modified arthrodesis it is easy to correct mal-apposition of the mid-tarsal joint surfaces, so preventing the pain which would arise quite apart from operative causes.

The simple measures alluded to are these, and can best be followed by the diagram. (A) shows the normal S-curve of the mid-tarsal joint. In the next (B) the head of the

the lateral displacement of the external malleolus on the shaft of the fibula (i.e. B equals C). As a contrast notice the X-ray tracing of a fracture (6b) where the relation of the external malleolus to the shaft of the fibula is reversed. Thus there must be a considerable shift of the shaft of the fibula away from the tibia—or diastasis. The reduction in this case (6b) was also unstable in that the displacement recurred at a fortnight when the swelling subsided. The fracture of the fibula was joined by a screw and the lower



a

FIG. 6.

b

end of the shaft of the fibula was screwed to the fibula. Plaster was worn for ten weeks: full activity was allowed at four and a half months.

I do not say that all abduction fractures become redisplaced, but in my experience a very considerable proportion do. Those that may remain stable have a fracture of the internal malleolus. If this unites in its proper position, the anchorage of the inner side prevents diastasis of more than 3 mm. But often, as in some examples shown, the internal malleolus does *not* unite. Where, as in the majority, the reduction has to depend on the integrity of ligaments only, displacement will recur, for healing is very slow in the inferior tibio-fibular ligament. This slow and uncertain healing of complete rupture of strong ligaments subject to considerable strain, is not exceptional. Consider, for instance, dislocation of the acromioclavicular joint. Although reduction is maintained for some months, the displacement recurs. Tears of the cruciate and internal lateral ligaments of the knee and tears of the interspinous ligament do not heal readily.

The amount of *ultimate* disability varies with the amount of diastasis. Wide diastasis, of course, is a crippling deformity, necessitating arthrodesis. In minor degrees the *ultimate* disability is often less than might be expected. For instance, a residual diastasis of 2 mm. is compatible with nearly full activity, the ankle not being troublesome, except during or after special exertion, such as running, or a walk over rough ground.

A constant experience, however, is the length of time it takes before the ankle reaches its maximum recovery—a year in most cases, sometimes longer.

If it is agreed that recurrence is likely, then, in the wider degrees, operation is imperative. Although operation is not *essential* in lesser degrees, it has the important merit of restoring full function much earlier than external fixation. (They can be A 1 in four months, instead of B 7 in a year). The operation is a trivial one—in fact, of little more account than the insertion of a Steinmann pin. I used to use screws, but the thread of an ordinary screw does not give secure enough fixation, as it is apt to cut out, and it is certainly not possible to dispense with plaster. The bolt has not this disadvantage. In fact, the fixation it gives is too rigid, and this is important. In full dorsiflexion of the ankle there is a shift of the fibula away from the tibia of about 2 mm. to accommodate the wider front of the astragalus. The bolt is apt to prevent this and, on two occasions, I have had to remove it in order to restore

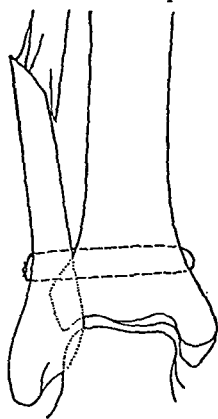


FIG. 7.

full dorsiflexion. I now use wire, inserted through two parallel drill holes (fig. 7). This gives adequate fixation and the necessary amount of resilience. External fixation is not necessary except when there is also a fracture of the internal malleolus, and then a plaster is applied when the swelling has subsided and weight bearing is allowed.

## Modified Subtaloid Arthrodesis

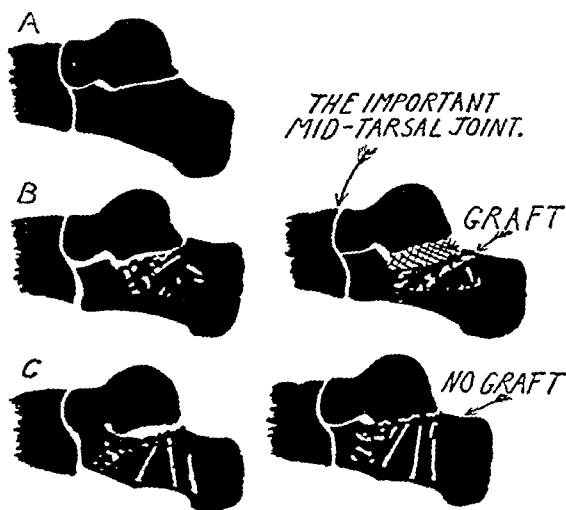
By W. SAYLE CREER, F.R.C.S.

THE subject of crush fractures of the calcaneus is topical because, so I am informed, many of our seamen are suffering from such fractures. But whereas in peacetime it was the man who fell down and hit the ground these men are injured by the ground, the deck of the ship, rising up to hit them, so to speak, because of submarine explosions of various kinds.

When it proves necessary to arthrodese the subtaloid joint in these cases it is usual to perform a triple arthrodesis. Such an extensive obliteration is necessary when the mid-tarsal joint surfaces are involved in addition to the talo-calcaneal. But the ankle, subtaloid and mid-tarsal joints together form a compound joint equivalent to the engineer's universal joint. It is true that each portion of it is capable of separate movement but in point of fact every portion is utilized every time we move the foot on the leg or the leg on the foot. To excise two-thirds of the joint as is done by the triple arthrodesis operation is not sound orthopaedic surgery if only one-third is damaged. If the integrity of the mid-tarsal joint is respected the patient is left with a much more mobile and useful foot.

It is quite obvious why surgeons include the mid-tarsal joint in their operation even when there is no reason for touching it. To obliterate the whole of the subtaloid joint it is necessary to open the mid-tarsal joint and that is the first breach of its integrity. Secondly, excision of the whole subtaloid joint results in a movement together of the head of the talus and of the anterior end of the calcaneus with a consequent alteration of the relative positions of the calcaneal and cuboid joint surfaces. A normal X-ray shows that the mid-tarsal joint is a slight S-curve, the articular surfaces fitting together with geometrical perfection (A). Excision of the whole subtaloid joint alters the coaptation in a manner similar to a fracture of the calcaneus with upward tilting of the anterior end (C) and results in secondary traumatic arthritis and pain in the mid-tarsal joint. This later pain is the reason why triple arthrodesis is generally performed.

It can be avoided by arthrodesing only the posterior half of the subtaloid joint, which will stiffen it just as effectively as if the whole joint were excised, but will not alter the coaptation of the mid-tarsal joint surfaces provided we take certain simple precautions.



Furthermore by this modified arthrodesis it is easy to correct mal-apposition of the mid-tarsal joint surfaces, so preventing the pain which would arise quite apart from operative causes.

The simple measures alluded to are these, and can best be followed by the diagram. (A) shows the normal S-curve of the mid-tarsal joint. In the next (B) the head of the



calcaneus is displaced downwards as a result of the deformity of the bone. When the posterior half of the joint is excised the head is restored to its normal position if we insert a graft of suitable thickness between talus and calcaneus.

In (C) we have the head of the calcaneus displaced upwards. This is found in some types of crush fracture and after arthrodesis of the whole of the subtaloid joint. Excision of only the posterior half without the use of a graft restores the mid-tarsal alignment to normal in cases of fracture, and prevents the distortion which follows excision of the whole length of the joint in other cases.

The method is illustrated in the following cases:

**CASE I.**—A drayman, aged 43, was seen in June 1937 complaining of pain following a crush fracture of the calcaneus six months earlier and treated elsewhere. X-ray showed irregularity of posterior part of subtaloid joint. The calcaneo-cuboid joint was undamaged but owing to the deformity of the bone the anterior end of the calcaneus was tilted upwards, thus destroying the perfect apposition of the mid-tarsal joint. Simple excision of posterior half of subtaloid joint restored the apposition at the mid-tarsal joint. Five months later he wanted to try light work but on account of adhesions of the foot generally a manipulation was carried out and was followed by physiotherapy. Final X-ray eleven months after operation showed good bony union and good restoration of the apposition of the mid-tarsal joint. The man was not seen again. A follow-up letter last month was returned "unknown".

**CASE II.**—A painter, aged 33, fell 30 ft. in December 1938. X-ray showed no distortion of shape, good mid-tarsal joint with badly damaged joint surface of posterior half of subtaloid joint. A few days later an arthrodesis was performed and this time in order to prevent alteration of the relative positions of talus, calcaneus and cuboid the bone excised was replaced by a graft of equal thickness. Cancellous os purum was used (because it is simpler to have the graft already prepared). Five months later he walked, on his own initiative, a distance of 20 miles, and his only complaint was a little aching and the loss of inversion. A follow-up letter sent to him this month has been returned "gone away".

**CASE III.**—In November 1937 a general labourer, aged 56, fell from a plank. X-ray showed crush fracture of calcaneus without deformity. Conservative treatment left a painful foot which we thought to be due to subtaloid arthritis, and in February 1939 arthrodesis of the posterior half was done with a graft of cancellous os purum to preserve normal relationship. X-ray showed condition four months later. It is a poor X-ray result yet there was no movement and no pain on straining the joint. The mid-tarsal joint was mobile and painless. X-ray nine months after operation showed that fusion is progressing. Symptoms of constantly varying nature followed. The result of arthrodesing the joint is good, but the case illustrates that owing to general damage to the foot the end-results may be poor.

In addition to these cases two patients suffering from spasmodic flatfoot with X-ray evidence of subtaloid arthritis have been treated in the same manner after an adequate period of conservative treatment failed to give relief.

**CASE IV.**—A female weaver, aged 25. The X-ray in October 1939 showed subtaloid arthritis. In February 1940 arthrodesis of the posterior half of subtaloid joint without graft. X-ray five months later showed solid joint and good apposition of the mid-tarsal joint. Symptoms gone, but arthritis has now affected the ankle-joint. When seen nearly three years since the operation, there was but little movement in the ankle which aches at times. The subtaloid joint is solid and painless. The mid-tarsal joint is freely mobile and painless. This case demonstrates the advantage of leaving a normal mid-tarsal joint, for if it had been arthrodesed she would have had that terrible handicap of a foot so fixed to the tibia that its functions of acting as a mobile base or plinth on which to stand and walk would have been abolished completely.

**CASE V.**—H. W., aged 22. Came in November 1941 having had a year's pain under the heel due to subtaloid arthritis. She had had several attacks of tonsillitis. Removal of tonsils, physiotherapy, plaster and gold injections had no effect.

In May 1942 arthrodesis of posterior half of subtaloid joint. In this case a form of graft was used by breaking up the bony surfaces much more than normally and by filling in some of the spaces with bone taken from the outer surface and interior of calcaneus. Three months later X-ray showed ankylosis taking place. Follow-up last month showed a painless rigid subtaloid joint, with solid fusion by X-ray, and a painless mobile mid-tarsal joint.

#### CONCLUSIONS

A method of arthrodesing the subtaloid joint so as to prevent or correct displacement of the bones forming the mid-tarsal joint is discussed. It obviates the necessity for triple arthrodesis after crush fractures of the calcaneus where the mid-tarsal joint surfaces are undamaged. It has proved useful in certain cases of crush fracture of the calcaneus and of spasmodic flatfoot.

<sup>1</sup> Arthrodesis performed within a few days of the accident in this case is an exception to my general rule.

## Section of Surgery

President—E. C. HUGHES, O.B.E., M.Ch.

[March 3, 1943]

### Some Revised Principles of Blood Transfusion

By P. L. MOLLISON, M.R.C.P.

*The four blood groups.*—Knowledge of the four main blood groups remains the foundation of safe blood transfusion. An impeccable grouping technique is therefore the first essential. The practice of taking a small drop of the blood to be tested and mixing it with a drop of each of group A and B serum on a slide is open to the following criticisms: Firstly, the use of undiluted blood considerably lowers the sensitivity of the test. Secondly, the carrying out of the test on a slide limits the time for which the reaction can be allowed to proceed, for if the mixtures are examined after too long a time, rouleaux formation may occur and obscure the interpretation of the test. If, on the other hand, the mixtures are examined too early, insufficient time may have been allowed for the development of a weak reaction. To overcome these difficulties, the tests should be carried out in small tubes, using blood diluted with citrate. A far more important criticism of the common method of blood grouping is its complete lack of controls. Thus, for instance, if no agglutination is noted, there is no guarantee that this is not due to loss of potency by the test sera. On the other hand, if agglutination occurs, this may be due to the serum having become infected or it may be due to auto-agglutination.

The simplest control that can be carried out in blood grouping is to test the serum for agglutinins as well as the cells for agglutinogens. Then, for instance, the diagnosis of group O is not accepted until the serum has been shown to contain both anti-A and the anti-B agglutinins. Test sera must be examined for their power to agglutinate cells which are poor in agglutinin content and for their absence of cold agglutinins, excessive rouleaux-forming property, &c. (see War Memorandum No. 9. To be published shortly. H.M. Stationery Office).

A comparatively elaborate technique of blood grouping is now practised by almost all the transfusion services in this country, so that as long as group O blood tested by them is used, mistakes are unlikely. Nevertheless, the use of group O blood without further testing for transfusion to all patients, irrespective of group, cannot be regarded as ideal. To start with, in handling very large numbers of bottles clerical errors may occur so that a bottle of group A blood, although correctly tested, is labelled group O. The only safeguard against this kind of mistake is the carrying out of direct matching before every transfusion. The omission of the direct matching test is only justifiable when carefully tested group O blood is being used and then only when circumstances are unusual, i.e. when there are no facilities for making the test or when there is no time due to the large number of cases being dealt with (after air-raids for instance). Urgency alone is not a sufficient reason because plasma or serum can always be used for transfusion while the blood is being tested.

Some authors have laid great stress on the danger of using group O blood, of which the plasma contains high titre agglutinins, for transfusion to persons of other groups. It has been shown, however, that destruction of the recipient's red cells only occurs when very high titre incompatible agglutinins are transfused. Moreover, this destruction, even when it occurs, is usually only slight and is not as a rule associated with any serious reactions. At the same time, this experimental work has made it clear that in peacetime the use of homologous group blood for transfusion should again become standard practice. Moreover, if less donors are available in peacetime it may become essential to use donors of all groups to satisfy the demands for blood.

*The Rh factor.*—Group O blood may prove unsuitable for quite a different reason, that is, because it contains some agglutininogen to which the recipient has become sensitized. Todd and White showed in 1910 that when the blood of one bull was injected into the circulation of another bull, the recipient bull rapidly developed antibodies which caused the destruction of the donor red cells. By contrast, Ashby showed that in man red cells transfused from one person to another survived for very long periods, namely about one hundred days. It therefore became accepted that in man, iso-immunization did not occur after the transfusion of blood of a compatible group or at least only occurred very rarely. Nevertheless, with the increasing interest in blood transfusion, particularly in the U.S.A., it began to be realized that the rapid destruction of transfused blood might occur although it appeared before transfusion to be compatible. The biggest single advance in blood transfusion since the discovery of the four blood groups (and of simple anti-coagulants) occurred when Wiener and Peters demonstrated the occurrence of iso-immunization in four patients who had received repeated transfusions. They showed that the blood of these donors contained a hitherto unrecognized agglutininogen (Rh) and that all four of the recipients lacked this agglutininogen. They postulated that these patients had become immunized to this agglutininogen and they succeeded in demonstrating specific anti-Rh agglutinins in the recipient's sera.

An equally important discovery was made by Levine and his co-workers who showed that a woman whose red cells lacked the Rh agglutininogen might, when she became pregnant with an infant whose red cells contained the Rh agglutininogen, react by forming anti-Rh agglutinins. They brought forward evidence to show that these anti-Rh agglutinins might pass from the mother's serum across the placenta and cause the destruction of some of the foetal erythrocytes, giving rise to the condition known as erythroblastosis foetalis. They also pointed out the danger of giving such a woman a transfusion of blood that was not specially selected, because if the donor's red cells contained the Rh agglutininogen the blood would prove incompatible. Since in this country 85% of people, irrespective of their ABO group contain the Rh agglutininogen only 15% of persons are suitable as donors for patients who have become sensitized to the Rh agglutininogen.

Thus, a new concept of compatibility has arisen. As well as satisfying the well-established rules of the four blood groups, blood must be specially selected for two types of recipient, that is to say, (1) persons of either sex who have become sensitized to the Rh agglutininogen by repeated transfusions and (2) women who have given birth to an infant affected with erythroblastosis foetalis.

*Stored blood.*—The object of the majority of transfusions is either to restore the blood volume or to supply functioning erythrocytes. Doubts about the value of stored blood only arise with regard to the second of these two functions. This question can only be settled decisively by showing that stored blood retains the capacity to take up and give off oxygen and then by showing that the stored erythrocytes after transfusion survive for long periods in the recipient's circulation. Quantitative survival studies have shown that blood stored for less than a fortnight in citrate-glucose solutions survives in the recipient's circulation almost as well as fresh blood. Blood stored for a similar period in a citrate solution without glucose is far more rapidly destroyed, however, and doubtless some of the feeling against the use of stored blood dates from the early days of the war when glucose was not being added to the blood during storage.

Absolute indications for the transfusion of fresh blood rather than stored blood are certainly very few. The treatment of platelet and prothrombin deficiencies may be mentioned; the value of fresh blood transfusions in the treatment of sepsis is a matter for argument. The chief advantages of stored blood are its ready availability and, not less important, the fact that there is time for the careful and deliberate carrying out of grouping and serological tests. One disadvantage of the use of stored blood, not often mentioned, is the danger of bacterial contamination, for the transfusion of infected stored blood may be fatal. This risk becomes very small indeed, however, when rigorous standards of autoclaving and of asepsis are maintained.

*Hæmolytic transfusion reactions.*—It is not generally realized that hæmoglobinuria and jaundice only occur after severe hæmolytic reactions and that a more sensitive indication of increased blood destruction can be obtained by examining a sample of blood taken from the recipient soon after the transfusion. Increased blood destruction is indicated by the presence of free hæmoglobin in the plasma or of an increased content of bilirubin. When evidence of increased destruction is found it should be possible in almost every case to discover the cause. One of the best ways of raising the standard of blood transfusion is to investigate all hæmolytic transfusion reactions. [References omitted owing to lack of space.]

## A Form of Bovine Serum Suitable for a Plasma Substitute in the Treatment of Shock. (*Abstract*)

By F. RONALD EDWARDS, F.R.C.S.

ANY substitute for human plasma must be retained in the circulation and eventually become metabolized. It must have an osmotic pressure equivalent to that of plasma, and should be non-toxic, free from antibodies, and non-antigenic. Substances prepared hitherto, have not fulfilled these criteria. Bovine serum provides a convenient form of plasma protein if it can be rendered safe for administration to man. Crude bovine serum agglutinates all human red cells and administration to man has been unsatisfactory.

Fractionation of the proteins and the preparation of pure bovine albumin have been undertaken, and the clinical trial of this material is awaited with interest. Fractionation necessitates a process involving considerable cost. The antibodies in bovine serum can be destroyed by heating the serum to 72° C., and preventing coagulation of the proteins by the addition of 0.2% liquor formaldehydi and 0.2% of 0.880 ammonia. Gelatification may occur in some samples, but can be prevented by the addition of a quarter of its volume of normal saline.

The blood is collected in the abattoir in sterile vessels and allowed to clot, the serum being syphoned off four days later. It is passed through wood pulp, and then, using the standard plasma filtration, collected in transfusion bottles. Processing is then undertaken as described above, and on cooling the serum is ready for use. It can be stored in a refrigerator or at room temperature and appears to be stable over long periods. The colour of the serum is changed to a greenish tinge, and the total solid content is as before processing, but the character of the protein is changed in part to a protein-complex, consisting of albumin and metaproteins. Tests against human red cells show that all the agglutinins and hæmolytins have been destroyed. The osmotic pressure exerted is practically that of plasma, and with further refinements in technique it is hoped to produce a solution of higher osmotic pressure. Transmission of tuberculous and abortus infection to man is prevented by using bullocks only, and by the Seitz filter.

Of the heated bovine serum, 400 c.c. and over has been administered to 24 patients in amounts up to 2,500 c.c. and at a rate, in two cases, of 1,200 c.c. in forty minutes. It appears to be safe to administer to man and is unassociated with any severe form of reaction. No rigors or serum sickness were seen. No albuminuria occurred in cases where it was previously absent. In a case of the hypoproteinæmia with œdema, the œdema disappeared. Anaphylaxis was tested for in ten patients, but was found to be absent.

Much further and more detailed study of this material must be made before any final assessment can be made.

## Some Aspects of Suprapubic Cystotomy. (*Abstract*)

By J. D. FERCUSSON, F.R.C.S.

THE operation of suprapubic cystotomy may be deemed advisable for a number of conditions demanding either drainage or exploration of the bladder. And its scope has to be modified to meet the demands of longer or shorter periods of drainage, and to give the necessary exposure required in individual instances. By far the commonest condition which calls for it is retention of urine, resulting most frequently from adenomatous enlargement of the prostate. In reports published ten years ago the operative mortality following simple drainage in cases of prostatic adenoma was placed between 3 and 36% and in unselected series of cases a mortality rate of at least 15% was to be expected from causes divided approximately equally between the urinary tract, and the cardiovascular and pulmonary systems. When one considers the all too frequent condition of such patients, particularly in the unselected state in which they are admitted to the municipal hospitals, one cannot but doubt that many are already moribund, while in others death would as certainly ensue and the patient suffer added discomfort as the result of a hasty and ill-timed operation.

It is generally agreed that the initial treatment should be a slow decompression of the bladder, which can be attained by either the so-called suprapubic "stab" operation, suprapubic puncture, or the in-dwelling urethral catheter; or in certain instances by perineal drainage.

Although the "stab" operation *may* be a minor procedure, certain anatomical variations may render it hazardous or impossible, and it does not admit of any degree of exploration of the bladder. Unless performed with previous exposure of the bladder or provision made for drainage of the perivesical tissues it carries a risk of extravasation and cellulitis, and, if carried out at a sufficiently high level to permit the comfortable wearing of a suprapubic belt subsequently, there is a danger of peritoneal injury. Moreover, it is sometimes difficult to perform without losing a small quantity of urine precipitately, and, as has been shown, the release of the first 30 c.c. may reduce the bladder tension by at least 25%—the very thing planned to avoid. Suprapubic aspiration, and the method of introducing a ureteric catheter with the aid of a small trocar and cannula carry similar risks.

The advantages of slow decompression by an in-dwelling catheter on the other hand, are, that it may be possible to restore adequate micturition without recourse to any operative procedure at all, and, if this cannot be achieved, the suprapubic region is left unblemished for suprapubic cystotomy or other operation to be carried out with a greater degree of safety and precision. In my opinion cystotomy should be performed as soon as decompression has been effected by in-dwelling catheter and a trial of natural micturition has proved abortive. Perurethral resection at this stage offers a more hazardous alternative, but at a later period, when improvement has followed cystotomy I have found perurethral methods of value in obtaining closure of the fistula and restoring adequate micturition, where enucleation has been contra-indicated. Continued catheter drainage for a time after decompression may, however, prove better in debilitated cases, and cystotomy can be subsequently performed with greater safety when circumstances permit. I find a gum elastic catheter of moderate size preferable to rubber except when dealing with calculous prostates, which are apt to bite into the present-day catheter within a few hours.

The operation of cystotomy should include, if possible, a digital exploration of the bladder lumen with reference to the prostatic projection and presence of other abnormalities, and free drainage must be established at the most favourable point. A vertical incision seems superior to the transverse in that there is less restriction on the level at which the drainage tube can be brought out, and it avoids opening up a further plane of loose cellular tissue over the rectus. I have been unable to confirm the presence of a fascial sheet, described as extending downwards parallel and deep to the transversalis fascia and dividing at its lower end to join the symphysis and bladder respectively. It has been postulated that by performing dissection in a horizontal plane to reach the bladder this fascia is divided in its upper unsplit portion, and infection of the cave below avoided. Be this as it may, I think the risks of perivesical infection have been exaggerated provided that free drainage is secured.

Difficulty may be experienced in finding the bladder, and I have several times seen lateral displacement, usually in the aged, without evident cause, such as a large diverticulum. A further pitfall is the retroverted bladder, which drops backwards into the pelvis; and my attention has also been drawn to the stalked bladder. For these reasons I think it always wise to operate on the moderately distended bladder, even though such variations are anticipated beforehand. Before being opened the bladder should be emptied by aspiration through a needle to prevent contamination of the surrounding tissues. It is important that the site chosen for drainage should lie high on its anterior wall, both with regard to fitting apparatus and to subsequent closing of the fistula, if desirable. If permanent drainage is anticipated the bladder may be sutured to the back of the rectus and the tube brought out moderately high through the skin incision, but not in such a way as to be strained obliquely or to render replacement difficult. In temporary drainage the bladder may be dropped well back on its tube, and the tube brought out more obliquely nearer the upper end of the wound. In either case drainage of the space of Retzius should never be omitted and is preferable at the lower end of the skin incision, being more direct at this point.

The majority of complications following the operation are dependent on neglect of the arrangements made for frequent lavage and routine changing of the suprapubic catheter. It is unfortunate that in many cases complete diversion of the urine is not secured, and in many, after a time, a small amount of urine finds its way periodically into the posterior urethra—occasioning a kind of strangury. Although sepsis undoubtedly renders the condition worse, I have noticed its occurrence with both clear and purulent urines, and in cases which have had both long and short periods of catheter drainage, and I think it occurs more frequently in bladders which have acquired a small capacity after cystotomy and are probably both hypertonic and hypersensitive. It may frequently be relieved by subsequent perurethral resection and allowing the suprapubic fistula to

close, though this should be performed early before the bladder capacity becomes too diminished. The presence of an infective lesion in the upper urinary tract may keep up the sepsis in the bladder, and in addition bring about a second complication, namely encrustation. Tube encrustation and blockage is more likely to occur with expanded-ended catheters, and for this reason a change to the plain type of catheter is advisable during the post-operative period as soon as a track is established. In such cases of neglected after-care the possibility of the development of infective lesions in any part of the urogenital tract should always be in mind, particularly epididymo-orchitis and pyonephrosis, the latter occasionally requiring temporary nephrostomy for its relief before natural drainage can be restored by bladder lavage.

Traumatic lesions affecting the urinary tract and demanding early cystotomy include injuries of the spinal cord, as well as of the bladder or urethra, and it should not be forgotten that such may co-exist, as this may affect the continuance of suprapubic drainage. Diagnosis of rupture is frequently difficult, and the suppression of urine associated with shock may give rise to false surmises. The picture may be more confused when, following an intraperitoneal injury, the patient has been able to get into an upright position, allowing blood to gravitate towards the pelvis, giving signs of lower peritoneal irritation. The combination of blood-stained urine drawn off by catheter with increasing swelling above the symphysis in association with a pelvic injury may be brought about by contusion without actual rupture. Exploration should, therefore, be carried out circumspectly, as the bladder may be difficult to find if lying collapsed in the traumatized area. A mid-line vertical incision is always best, even though extension may be required, to deal with a further suspected intraperitoneal injury. In this respect a bloody discoloration of the exposed peritoneum does not necessarily indicate intraperitoneal bleeding, but it is safer to look and see. Drainage of the perivesical tissues is the urgent need in purely extraperitoneal ruptures, but in all cases, especially with inaccessible tears, drainage of the bladder itself is desirable if circumstances permit, while with intraperitoneal rupture formal cystotomy drainage after closure of the rent and peritoneum is safer than relying on an in-dwelling catheter. In ruptures complicated by pelvic injury bladder drainage should again be as high as possible since sequestration may otherwise lead to a persistent fistula low over the pubis. Such treatment will also apply to open wounds of the bladder, and in cases where there is much loss of tissue affecting the anterior part of the bladder every attempt should be made to separate what remains of the bladder from the under-surface of the symphysis to prevent subsequent adhesion.

Rupture of the urethra requiring cystotomy drainage needs no essential modification of this procedure, apart from the fact that complete diversion of the urinary stream in penile ruptures is difficult to obtain without establishing suction drainage. Occasionally it may prove difficult of performance as in one of my cases in which a man sustained a compound rupture of the penile urethra from the dorsum in combination with severe laceration of the suprapubic region by a bomb fragment. In this case it was felt that any further disturbance of the prevesical tissues might prejudice the vitality of the remaining portion of his penis, and urethrotomy drainage was established temporarily with satisfactory results.

## Lumbar Procaine Block and Sympathectomy in Arteriosclerotic Endarteritis. (*Abstract*)

By HOWARD R. IVES, M.D.

PATIENTS with arteriosclerotic endarteritis have received less attention in recent years, in the first instance because the results of any treatment are frequently disappointing, and in the second place because clinicians and investigators have assumed that the disease is an end process in which vasospasm does not exist. Homans (1939), Brown (1926), and others have in the past expressed this belief and it is such general thought which has greatly influenced progress in this disease. Flothow (1931) and Reichert (1933) have reported good results in the treatment of claudication with lumbar paravertebral alcohol injection. Harris (1935) has performed sympathectomy on a group of 12 cases with peripheral arteriosclerosis. 42% of these patients had a good result. These, however, seem to be the only reports dealing with this special treatment of patients suffering with arteriosclerotic arteritis and not Buerger's disease. Medical therapy as represented in intermittent venous occlusion, Buerger's exercises, contrast baths, Paevex boot and serum therapy as recently suggested by Hayward (1942) has benefited many cases considerably and is the first line of defence, but the relapses are well known and frequent.

**Clinical tests of vasospasm.**—Earlier workers have rejected these patients for sympathectomy as there was no adequate means of estimating the improvement which sympathectomy would bring. Brown (1926) was the first to devise a method for the selection of suitable cases in Buerger's disease. He produced vasodilatation by an intravenous injection of typhoid organisms. Local procaine injection of peripheral nerves produces peripheral vasodilatation. Spinal anaesthesia produces complete relief of vascular spasm in the extremities, and by the change in temperature one can predict the improvement to be expected by sympathectomy. White (1930) first suggested and used lumbar and thoracic procaine injection of the sympathetic chain as a clinical test. Flothow (1931) and Reichert (1933) have used this method to advantage and have furthered its application in the same manner with alcohol block. Procaine block gives one easily the results to be expected from the more permanent alcohol block or sympathectomy. It gives information likewise concerning the relief of pain which the previously mentioned tests cannot produce. One can test the improvement in the onset of claudication after procaine block and use the opposite extremity as a control for temperature studies.

**Technique.**—The Labat (1930) technique of paravertebral injection of the lumbar sympathetic chain seems the easiest because of anatomical landmarks. The lumbar spines are readily felt with the patient lying prone or on his side. From a point 3 cm. lateral to each spine, an 8 to 10 cm. needle is passed vertically until contact is made with the transverse process, usually 3 to 4 cm. below the skin. The needle is then redirected 10 degrees inwards over the upper edge of the transverse process and pushed on until contact with the vertebral body is made. The needle does not have to be in contact with the sympathetic chain as the rami communicantes come posteriorly from the ganglia and the 5 c.c. of procaine injected at L2, 3 and 4 diffuse rapidly. Effect as shown by increased temperature, absence of sweating and loss of pain should appear soon after the injection. In a group of thirty procaine injections, I have seen no undesirable sequelae. Skin temperatures may be measured by a thermocouple or a sensitive skin thermometer. By testing change in claudication, temperature and pain after lumbar procaine block, the final effect of sympathectomy can then be closely estimated.

**Clinical cases.**—Lumbar sympathectomy has been performed on seven cases, three having a bilateral one-stage operation. The average age was 60. All the patients had severe intermittent claudication without gangrene. All patients had absent pulsations in the popliteal, posterior tibial and dorsalis pedis arteries. The Wassermann reactions were negative, urine specimens showed no sugar, and calcification was present in the affected limbs of each case. Four of the seven cases had previous medical therapy consisting of intermittent venous occlusion, serum, or both. All patients had a pre-operative lumbar procaine block and responded with a satisfactory temperature response in the leg and foot. One patient with bilateral severe claudication was not improved in any way. The remaining six patients have been greatly improved, can now walk considerable distances without pain, and are again at work. As the first sympathectomy was done less than a year ago, it is far too early to conclude a result. One cannot hope to cure these patients, and they must realize that frequent rest and walking slowly are prerequisites of their continued improvement.

#### SUMMARY

Patients with arteriosclerotic endarteritis do have considerable vasospasm associated with the disease process. This can be adequately demonstrated by lumbar procaine block and the resulting temperature and claudication change in the limb. Contrary to previous thought, there would seem to be a group who can be greatly benefited by sympathectomy. The fact that sympathectomy has achieved good results after the failure of medical treatment would suggest that we have an additional therapeutic measure for the treatment of these unfortunate cases.

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[May 5, 1943]

**Acute Osteomyelitis Treated Conservatively.**—D. H. PATEY, M.S.

M., aged 14, admitted on October 3, 1942, to a medical ward, with a history of general malaise, a feeling of sickness, constipation and fever, which had begun four days previously. There had also been pain in the lower part of the right thigh, which at first was slight but had progressively increased.

*On examination.*—Temperature 103.5°, pulse 118, respiration 28. Tenderness and slight fullness over the lower third of the right femur. Blood culture negative. Leucocytes 18,500 (85% polymorphs.). X-ray of femur negative.

A diagnosis was made of acute osteomyelitis, beginning in the lower end of the right femur, and he was treated by resting the limb in a plaster shell, and sulphathiazole 84 g. was given in just over a fortnight, the highest blood level being 4.7 mg.%. The first X-ray evidence of bony disease was obtained on November 2, when a radiograph showed periosteal thickening. He continued with swinging temperature and moderately severe pain until December 3 (i.e. two calendar months after admission) when a large abscess behind the lower end of the right femur was opened and drained by incisions on either side. The abscess was immediately behind the bone, but no bone stripped of periosteum was found. The pus grew *Staphylococcus aureus* in pure culture. The abscess discharged for some weeks, but when he left the hospital on January 11, 1943, the wounds were healed. As regards leucocyte response, in the first three weeks when he was having sulphathiazole the white cell count fell to 9,100 (80% polymorphs.), by the end of four to five weeks it had risen to 28,600, but by the time of drainage of the abscess it had fallen to 15,000, in spite of the fact that no further sulphathiazole was given during this time. During the whole time until the drainage of the abscess, he suffered continuously from moderately severe pain, which was controlled by veganin and occasional morphia. He also looked pale and had an appetite which required coaxing. His blood-count dropped to 4,400,000 reds and 80% hæmoglobin and he was given a transfusion of a pint of blood. After drainage of the abscess his symptoms rapidly disappeared and he became a normal, healthy boy. He was discharged using crutches, which he soon discarded, and by the end of February he was walking well and was back at school. He is now a healthy-looking boy, the movements of the knee are almost normal, the wounds are healed, though they still occasionally discharge, there is very slight bony thickening over the lower half of the right femur, and slight wasting of the quadriceps, which, however, is rapidly disappearing. X-ray shows periosteal thickening and slight mottling of the bone over the lower half of the right femur but there is no obvious sequestration.

**Carcinoma of Œsophagus—Treated by Excision and Reconstruction of Ante-thoracic Œsophagus.**—P. R. ALLISON, F.R.C.S.

M. A. S., female, aged 54.

*History.*—When first seen in September 1941 had complained of dysphagia with solid food for six months. Food appeared to be held up at about the middle of the sternum. There was no loss of weight. Dyspnoea on exertion for seven years associated with some cardiac irregularity, but no swelling of the feet.

*Œsophagoscopy.*—Showed an ulcerating neoplasm of the Œsophagus 30 cm. from alveolar margin, and a biopsy from this showed it to be a squamous carcinoma.

*Operation.*—21.10.41: Under general anaesthesia the abdomen was opened and no secondary deposits found. A loop of jejunum was isolated and anastomosed to the posterior aspect of the stomach. The other end of the loop was brought through the abdominal wall under subcutaneous tissue and through a stab wound in the skin just below the left costal margin. The continuity of the jejunum was restored and a jejunostomy performed.

18.11.41: The left pleural cavity was widely opened after resection of the 8th and 9th ribs. The lung was not adherent. Local anaesthetic injected into posterior mediastinum and superior mediastinum. The lateral pulmonary ligament was divided. The posterior mediastinal pleura was incised at the extreme lower end and the Œsophagus isolated and held by a rubber catheter. The forefinger could then be passed upwards between the growth and the pericardium in front and between the growth and spine behind. On both postero-lateral aspects it was fairly well anchored by thickened tissue. The finger was left in the mediastinum behind the Œsophagus and the cellular tissue



between this and the aorta divided, leaving as much of it as possible adherent to the œsophagus. A few vessels were ligatured. Normal œsophagus was then found above the growth, isolated, and secured with a catheter. The organ was then rotated and the rather denser tissue on the right postero-lateral aspect divided and vessels were ligatured. Tunnelling under the arch of the aorta was then performed to free the œsophagus as high up as possible. The œsophagus was then divided at the lower end and invaginated. The muscular coat was incised first and separated from the mucous coat. The latter was then crushed and divided and the muscular coat sewn over. Sulphanilamide was sprinkled into the mediastinum and an under-water drain passed up to the site of the growth. The left lung collapsed completely during the operation and did not reinflate against pressure. The chest was closed. She was then turned on to her back and an incision made at the root of the neck on the left side. The œsophagus was exposed, isolated by blunt dissection and pulled up into the neck. The growth was excised with a few inches of normal œsophagus. A tunnel was made in the subcutaneous tissue of the chest and a groove cut in the clavicle. The œsophagus was then threaded through to emerge through a stab hole in the skin.

*Post-operative notes.*—After operation the left lung expanded satisfactorily. During the following three months a series of plastic operations was performed to make a new œsophagus out of the skin of the anterior chest wall. This was anastomosed above to the œsophagus and below to the upper end of the isolated jejunal loop. The new œsophagus was covered by skin flaps which were elevated from the chest wall.

The patient was discharged home on the 9.5.42 and since then has been swallowing fluids and soft solids satisfactorily.

Slight stenosis has occurred at the junction of the œsophagus and skin tube and this has been dilated with bougies on two occasions.

She has gained 2 st. in weight and remains free from any evidence of recurrence.

#### **Specimen of Ante-thoracic Œsophagus.**—P. R. ALLISON, F.R.C.S.

Removed at post-mortem from a patient whose œsophagus and upper half of stomach were removed for a carcinoma of the abdominal œsophagus involving the stomach.

He survived the operation to die of secondary deposits one year later. During life he constantly complained of some pain at the junction of skin tube and stomach pouch.

The specimen exhibited showed a peptic ulcer at the junction of skin and gastric mucous membrane.

The following cases and specimens were also shown:

Mr. R. S. Corbett: (1) Tuberculous Tenosynovitis of the Hand. (2) ? Second Primary Carcinoma of the Gastro-intestinal Tract.

Mr. T. Holmes Sellors: (1) Mediastinal Dermoid Ruptured into Pleura. Successful Removal. (2) Pneumonectomy for Tuberculoma. (3) Pulmonary Lobectomy for Cyst. (4) Neurofibroma of Chest. (5) Pneumonectomy for Carcinoma.

Mr. R. C. F. Catterell: Carcinomatous Swelling of the Mandible.

Mr. C. Patrick Sames: Salivary Gland Tumour of Uvula.

Mr. Howard G. Hanley: Tuberculous Perinephric Abscess.

## Section of Psychiatry

President—J. BRANDER, M.D.

[March 9, 1943]

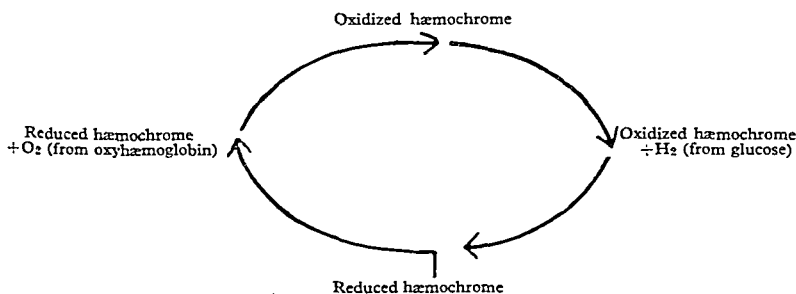
### Hypoglycæmia as an Experimental Psychosis

By W. MAYER-GROSS, M.D., L.R.C.P.Ed.

(From the Department of Clinical Research, Crichton Royal, Dumfries)

THE possibility of producing an experimental psychosis is naturally limited in human beings. Drugs like mescaline and hashish have been used for this purpose because of the striking "positive" symptoms they produce; psychiatrists have made observations on the effect of anæsthetics like ether, nitrous oxide or sodium amytal. The knowledge won from these experiments can scarcely be compared with the wealth of facts on hypoglycæmia accumulated since Sakel introduced the daily repeated hypoglycæmic coma as a therapeutic procedure almost ten years ago. His bold method only yields therapeutic results if the hypoglycæmia is of such a degree that serious cerebral symptoms appear. This gives to the physician practising insulin treatment the opportunity of observing the same patient for weeks under identical conditions. Since the Vienna school published the first descriptions of unusual neurological phenomena, much data on symptoms and pathology have been collected by workers all over the world. The field is already so large that it is not easily surveyed in a short paper, the more so as many points are still controversial, and I propose, therefore, confining myself strictly to personal observations and problems in which I took special interest. The idea of our investigations as well as of the present survey, is a better understanding of hypoglycæmia, its therapeutic action in psychoses and, if possible, improvement in our results.

*Pathology.*—In discussing the pathology of hypoglycæmia, one has to remember that although insulin has no direct effect on the C.N.S., all its important symptoms are psychological and neurological. In reducing the sugar content of the blood it deprives the brain of its fuel. Biochemists have called this starvation of the brain anoxia. They use this term in a wide sense meaning not only lack of oxygen supply but any interference with oxidation. It may result from either deprivation of oxygen or absence of glucose available for oxidation. The following diagram of brain oxidation, omitting factors unimportant in this connexion, may illustrate this point.



Hæmochrome being a pigment found in all nerve cells, has a somewhat similar function to hæmoglobin in blood. Glucose is oxidized when it reacts with the oxidized hæmochrome. Glucose is practically the only food supply of the C.N.S. and consequently one can say that the oxidation of glucose is the chief biochemical function of the nerve cell. The resultant symptoms and other consequences of the anoxia may well differ according to which part of the oxidation process is interrupted. It seems remarkable that the two other therapeutic methods which prove successful in psychotic conditions, continuous narcosis and convulsions, also interfere with cerebral oxidation, though in a different manner and probably in different areas of the brain. Viewing the three physical treatment methods together and forgetting their theoretical origin, one can conceive a plausible hypothesis and a fruitful rationale of these therapies. The transient and reversible lowering of cell oxidation during therapy has a rebound effect on the metabolism

of a brain the cells of which are functioning abnormally because of an unknown factor causing the disease. To bring about a lasting improvement, this rebound effect has to be repeated or—in the case of continuous narcosis—the period of lowered oxidation has to be extended for some time in order to be followed by an effective overshooting from which the normal level is ultimately restored (Gerard, 1938).

*Blood sugar and symptoms*.—The clinicians describing hypoglycæmic symptoms in diabetics (Sigwald, 1932; Wilder, 1936) had no doubt that their severity was dependent on the level of blood sugar. When psychiatrists began to produce deep comatose conditions which were regarded as alarming in the treatment of diabetics they soon discovered that the blood sugar level was not a reliable indicator of the depth of unconsciousness and of the danger involved. It was often found higher during the coma than it was before the patient became completely irresponsive to stimuli. The blood sugar falls within the first hour after injection of insulin to a level between 25 and 45 mg. % and, with slight fluctuations, stays at this level until interruption by nasal feed. The fall is not accompanied by symptoms until the blood sugar has been low for some time. They then increase gradually and in the classical procedure coma, the degree of unconsciousness which is regarded as therapeutically effective, does not set in until at least another hour has elapsed. On the other hand raising the blood sugar level by intravenous application of glucose solution brings the patient out of the coma at once and restores consciousness within a few minutes.

These paradoxical observations have been widely discussed and many explanations proposed. One worker went so far as to doubt if hypoglycæmia was the primary cause of the psychological picture and to suggest a hypothetical intermediary substance as the direct causative factor. Others alleged the sugar content of the C.S.F. to be closely correlated to the nervous symptoms and considered it a better indicator of the patient's condition than the blood sugar level.

One of the difficulties in this controversial field is the generally recognized but not always heeded fact that the stimulus of the pin-prick in taking a specimen can in itself raise the blood sugar level in a patient under insulin, perhaps more so than in an average person. Everything depends upon a meticulous technique and careful parallel observations on the part of the clinician.

A long series of investigations in a patient who is pricked every half-hour must necessarily give a distorted curve. It seems well established that during coma blood sugar fluctuations within a certain range have no direct relation to clinical symptoms, but this is different before the onset of coma when the patient is still wakable and the degree of dimming of consciousness varies much more. We found that these variations are in fact closely correlated to blood sugar fluctuations, that it rises when the patient is awakened and goes down if he becomes clouded again. That this correlation ceases with the onset of coma can best be explained by a theory which assumes that the mechanism of the precomatose clouding of consciousness has a different localization in the brain from that of the coma. The latter is probably due to a trigger mechanism localized subcortically, perhaps in the diencephalon, while the former is a reaction to the blood sugar level of the cortex which as proved experimentally is more sensitive to variations of glucose supply than any other part of the brain.

*C.S.F. sugar and symptoms*.—The C.S.F. sugar level is somewhat higher than the blood sugar and follows the fluctuations of the latter with a time lag of fifteen to thirty minutes in insulin treatment as it does under normal conditions. Because of this time lag it was always found relatively low when taken at the same time as the blood sugar which was increased through the stimulus of the lumbar puncture. When this was taken into account and the specimens timed accordingly, the C.S.F. sugar proved to be a much less reliable indicator of clinical symptoms than the blood sugar level. Twenty minutes after an intravenous glucose injection which pushed the blood sugar up to over 200 mg. % and awakened the patient completely, we found the C.S.F. sugar almost at the same level as before the glucose injection.

*Clinical picture*.—If I now describe and discuss the symptoms of hypoglycæmia, it may be objected that the observations are gained from patients suffering from a mental illness; in our material the majority were schizophrenics, the others manic-depressives and a few psychopathic personalities. The answer is that identical symptoms were seen in diabetics before psychiatrists used insulin. Further the great variety of symptom-complexes comprised under the heading schizophrenia makes abstraction from the basic abnormalities of the patient relatively easy. Moreover some brave colleagues in Switzerland and Germany have undergone the experience themselves and contributed interesting self-observations.

The most characteristic signs of the hypoglycæmic psychosis are a combination of

clouding of consciousness with excitation of the autonomic nervous system. Loss of consciousness followed by amnesia is not only found in the more severe states produced in insulin treatment; Sigwald mentions amnesia as a universal symptom of the various pictures in milder hypoglycæmia in diabetics. Clouding sets in without the patient being aware of it, similar to anoxia where the lack of insight may lead to dangerous situations if happening to a pilot in an aircraft. The feeling of extreme fatigue with sleeplessness so characteristic for insidious oxygen deprivation seems unknown in hypoglycæmic anoxia.

Many patients sink into hypoglycæmic unconsciousness without waking up from the preceding normal sleep. In some cases one hears descriptions of changing colours, glittering lights, or paræsthesia around the mouth in this stage. Little of this period is remembered after the waking up from coma or later. Most patients feel hot and perspire before they lose consciousness. There are no dreams or nightmares even if at the beginning of treatment the doses are too small to produce coma. Complete amnesia covers the various often striking motor symptoms. During the waking-up period, however, after dispensing of sugar, consciousness often returns before other symptoms disappear, and in this stage, which is well remembered, interesting subjective experiences are not infrequent.

*Self-observation.*—The following self-description of a doctor patient illustrates some of the typical features:

I write to-night, at ten minutes past nine o'clock of my impressions and sensations on recovering from a hypoglycæmic coma into which I entered this morning. I remember lying down in bed when I had received the injection of insulin and also the orderly taking my pulse-rate twice, at intervals. I remember nurse coming in later and I gave him the magazine "Life" to read. That was the last recollection I have, previous to coma. The next happening that I remember is waking up and sitting up in bed at ten minutes past ten o'clock. I asked the nurse who was looking at the charts the time. I felt very wide awake and asked if I could have a drink of glucose as I was intolerably thirsty and had a craving for a sweet drink. Sister looked in at the door just at that moment, and said that I could not have a drink just then but I would be given one later. I must have suddenly gone into coma immediately after this as I do not remember anything until I heard very distantly the voices of the doctor and sister. I do not now remember what they were saying. I saw the doctor's and sister's faces. Doctor asked me repeatedly if I was awake and slapped me lightly on the left cheek, as he usually does when I am recovering from a coma. I could not speak and I felt very helpless and confused mentally. The next recollection I have is of the nurse's white worried face with its distended temporal arteries and forehead veins looking down at me and asking me if I was all right. He asked me this question two or three times but I could not answer him. He felt my pulse and arranged the bed-clothes *rapidly—very rapidly—it seemed to me, two or three times*. I was conscious of a tremendous effort I seemed to be making to avoid slipping into a land which was different from that of the nurse's, as being a land or "life" of no movement. The nurse seemed to me to be making also a terrific effort to help me, to bring me back to his life. I felt fully conscious of this intensive and combined effort and strove or seemed to strive with all my powers to drag myself back from this abyss of "no movement". I do not recollect moving my limbs, on the contrary I seemed to be paralysed in my voluntary movements. After a long struggle in which at times I thought that I could not make the effort any longer, I found that I could speak and I felt an overwhelming sense of gratitude to the nurse whom I hailed as my "saviour". I had an intolerable thirst and also felt very hungry. I asked the nurse for sweet drinks and he brought me a glass of tea and sandwiches of which I ate three or four. I insisted on the nurse having a sandwich which he did to please me. I also insisted that he should have a drink, but he replied that he would have one later. Sister came in then and I discussed the question of glucose and its relation to obesity.

Four characteristic points in these recollections deserve more detailed discussion.

(1) Stage of "akinetic mutism". The patient sees and hears, but is unable to speak or to move. This condition is more often observed objectively than remembered by the patient; it occurs on going into coma, lasting often for half an hour, as well as during the waking period. The patient follows with his eyes slowly, seems to look at the person approaching him, but remains mute and without movement. If touched or pricked he moves purposefully in small movements away from the stimulus. Since Cairns and his collaborators (1941) have reported a similar condition in a girl with a cyst in the hypothalamic region I tried to get an account of subjective experiences in this akinetic state by rousing the patient quickly with intravenous glucose. The descriptions received were not conclusive, and were reminiscent of what one hears from some patients coming out of a catatonic stupor. Some say they did not realize that they were akinetic, one that he did not care to move, another that he felt too weak and still another he found it impossible although he tried hard to respond. The condition may be compared with what Economo described as "body sleep" in encephalitics.

(2) Sensory anomalies. The majority of the visual sensations are similar to those observed in falling asleep or in other states of clouded consciousness (Benedek and Angyal, 1939). One of the rarer sensory anomalies was our patient's observation that the nurse's movements when arranging the bed-clothes appeared to him very rapid. This phenomenon of increased speed of seen movements was described by Poetzl (1928) in a patient with an occipital lesion and called "quick motion picture illusion". A number of identical observations have since been reported, most of them in hypoglycæmia (Weil, 1941). Against Poetzl's theory suggesting an insufficient co-operation of timing between the two hemispheres, it has to be remembered that our patients often have staring eyes

of a brain the cells of which are functioning abnormally because of an unknown factor causing the disease. To bring about a lasting improvement, this rebound effect has to be repeated or—in the case of continuous narcosis—the period of lowered oxidation has to be extended for some time in order to be followed by an effective overshooting from which the normal level is ultimately restored (Gerard, 1938).

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The most characteristic signs of the hypoglycæmic psychosis are a combination of

individual pattern of movements repeated in a constant order every day. This predilection pattern has nothing to do with the underlying schizophrenic condition. The mouth movements reminiscent of grimacing catatonics are seen in patients who never had catatonic symptoms, in obsessionals and psychopathic personalities.

*Individual differences.*—It is difficult to account for the *individual differences* in motor symptoms which are completely unconscious and caused by the functional and reversible interference with cerebral function. A clue to the differences may be obtained from the fact that the pattern of movement when the patient goes into coma is often different from that of the same patient when he wakes up. Not only is the hyperkinetic waking-up stage, as one would expect, much shorter, but the symptoms can be totally different in character. In one part of the film to be shown a patient goes into coma with general twitchings similar to those provoked by short electric stimulations of the cortex; the same patient wakes up with complex, co-ordinated climbing movements. As the insulin effect acts much slower in disturbing cerebral function than the overflow of dextrose in the blood in restoring it, it may well be the difference in time which produces the completely dissimilar symptoms. The importance of the time factor can also be seen by comparing the symptoms in the same patient if insulin is given intravenously instead of subcutaneously. Many authors have recommended the intravenous method in cases presenting a difficult nursing problem because of their extreme restlessness, as the quicker action of intravenous insulin shortens or may even abolish the hyperkinetic interlude. If the time factor is responsible for the disparity of individual symptoms, systematic investigations comparing the same patient's reactions after intramuscular with those after intravenous insulin injections should be clarifying. We found indeed not only quantitative differences, but qualitatively different patterns of symptoms.

By elucidating the influence of the time factor in our experimental psychosis, some light should be thrown on the difficult problem of the multiformity of neuropsychiatric symptoms in other functional diseases.

*Localization.*—In attempting to localize the more complex hyperkineses, it is important to note that they appear either on the way to the stage of decortication in coma, or while the brain is returning to normal function from this stage. The movements can, therefore, be interpreted as release symptoms from removal of higher cortical control. For their explanation in detail we would have to know more of the vulnerability of the different parts of the brain to hypoglycæmic anoxia.

There are certain groups of movements in which the idea of stimulation in a functional unit can serve as a fruitful hypothesis. Thus movements of the mouth and face which are the first signs of beginning hypoglycæmia appear simultaneously with perspiration, which is the signal of starting autonomic hyperactivity, this while the rest of the body is still relaxed and unaffected. The picture of pursing, pouting, sucking, protruding of the tongue, &c., are certainly reminiscent of the movements of the newborn infant during the first few months of life before the cortex is developed and functioning. Nevertheless, they may be signs of irritation in a certain small area of the cortex. I doubt if they can be localized in one of the many levels where the components of the feeding reflex, sucking, chewing, swallowing, &c., are integrated. Probably all levels connected with the function of feeding are activated at the same time. If, however, one tries to give such a patient a drink, he is unable to take it because the separate movements are not co-ordinated, probably on account of the partial cortical impairment. At the same time the facial region is found hypersensitive to touch. The obvious interpretation of this oral syndrome appearing so early in hypoglycæmia is to be found in the state of starvation produced by insulin. The starving organ, the C.N.S., reacts with excitation of those of its parts which normally subserve the removal of such an emergency. Thus the activity of a *functional unit* of the C.N.S., not the disturbance of a certain level releasing lower levels, produces the special hyperkinesis.

It is probable that another frequent syndrome characterized by climbing movements can be interpreted in the same way. This syndrome appears at a later stage of hypoglycæmia when decortication has progressed further. Climbing movements are always combined with reflex grasping of the hands and fingers, and sometimes of the toes. Alternating movements of the arms or feet appear first. Later the arms reach above the head, the body is doubled up, and, if possible, the patient pulls himself headwards. If fully developed, the climbing syndrome also includes the arc-de-circle posture alternating with flexion of the body. All these movements remind us of our tree dwelling forebears. One is also reminded of kicking and related movements of the young infant; again the grasping of the human infant has been interpreted as a relic of the stage when the feeding young ape had to hold on to the mother's hairy breast. The reference to phylogenesis is particularly legitimate here because of the striking similarity of the

and little movements of the eyeball. Physiologists have shown how much our judging of the speed of movements depends on our eye movements following the moving object, and recourse to a central disturbance therefore seems unnecessary.

Skin sensations and disturbances of the "body image" although not mentioned in the doctor's self-description are numerous and often most peculiar in character. They deserve special study in the light of sensory physiology. For instance one of my patients regularly described what she called "a cardboard feeling" of her body which was "lifeless and flat without thickness". She felt life and solidity return from the feet upwards. Another patient described "pins and needles" in his legs, felt not in the skin itself, but at a distance of about an inch outside the skin.

(3) The struggle for consciousness. Many patients speak of the enormous effort they are making to drag themselves back to reality. Our doctor projects this to the nurse in whose face he believes he sees the same exertion he himself is experiencing. This effort to pull oneself out of the grave, away from the dark, is sometimes expressed in dreams and fantasies; a young man described it as "a fight with the devil", he had to make his way "through different stages against the powers of darkness like Dante's journey through the circles of hell". A more sober-minded curate of the Church of England had to count the lights in the room and make sure that they were all present and fixed at the right places in order to convince himself that he was alive in the same world as before.

(4) This struggle is followed, as in the doctor's descriptions, not only by a feeling of relief but by happiness, elation and sometimes by a euphoric over-valuation of the patient's mental and physical faculties. A fellow-feeling with the other patients, with everything and everybody, and expressions of overflowing sympathy are frequent. As one would expect the opposite sometimes occurs, viz. a feeling of strangeness, of inability to get in touch with reality which appears distant and inaccessible. In three cases derealization lasting for several hours after the treatment was encountered.

If one considers the struggle for consciousness during awakening together with the psychological picture of akinetic mutism one is tempted to speculate about the role played by the cortex in hypoglycemia. It is the first to be affected by the withdrawal of fuel, but it seems that when the abundant supply of glucose is returning in the blood-stream recovery does not follow in the reverse order, but instead the lower centres and the restored consciousness looks on as the spectator trying to help the restitution of motor and sensory normality.

*Signs of autonomic excitation.*—Signs of a heightened excitation of the autonomic nervous system accompany hypoglycemia from its beginning to its end and are as characteristic as the disturbances of consciousness. Perspiration, dermatographia, flushing and paleness, changes in the size of pupils, in pulse pressure, increased secretion of saliva, of tears and of gastric juice are present in every case. If one directs one's attention on the autonomic symptoms one may be tempted, as Fortuyn (1941) suggested, to consider hypoglycemia as a disturbance of the hypothalamic autonomic centres, regarding all other symptoms as secondary. Although both divisions of the autonomic system show increased activity throughout, the facts can best be understood as the result of the struggle of the sympathetic-adrenal mechanism against the parasympathetic effect of insulin. The counter-action of the adrenal medulla against insulin, first discovered by Cannon in 1924, is strongest in the precomatose stage, but it continues in coma when, judged from the pupillary findings and from the pulse pressure, parasympathetic tone gains the upper hand. These humoral manifestations of hypoglycemia have naturally attracted the interest of many workers, especially as they provide an alternative theory to explain the therapeutic results of the treatment. Are they only peripheral reactions or do they signify an excitation of the diencephalon following reduction of cortical control? Systematic temperature observations carried out in collaboration with F. Berliner (1941-42) have demonstrated that a direct effect of hypoglycemia on the hypothalamus is probable. We are still far from a full understanding of the interaction of periphery and centre in this field, and the relations between cortex and hypothalamus in hypoglycemia remain obscure.

*Motor symptoms.*—The discussion of the striking motor symptoms in hypoglycemia has been left for the last part of this survey because they are the most variable and least constant symptoms. Approximately 5% of our patients had no spontaneous motor signs at all except for general muscular rigidity occurring together with pyramidal signs during coma. They pass from sleep into coma, exhibiting only the movements of a normal sleeping person. Others show motor excitement from the beginning, starting with movements of the mouth and face, followed by rhythmic movements of the head and arms, later spreading to the whole body, which is seized by an extensive and severe restlessness. One sees rolling, turning, rocking, kicking movements resembling chorea and athetosis, and myoclonic twitchings of the extremities which increase and may involve the whole patient sometimes culminating in an epileptiform fit. As a rule the patient becomes quiet when he goes deeper into coma, but his muscles are in what can be called decorticate spasticity and remain so throughout the hour of coma; restlessness reappears during the waking-up period.

This description becomes less complex if it is realized that each patient has his

[April 13, 1943]

## Suggestibility and Hypnosis—an Experimental Analysis

By H. J. EYSENCK, Ph.D.

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THEORIES of suggestibility fall into three main classes. The first group of theories is based on certain permanent or semi-permanent characteristics of the person who accepts the suggestion—the suggestee. An explanation may be sought in his neurotic constitution, in his submissive instinct, in his tendency to dissociation, or in his ignorance, credulity, or stupidity.

The second group of theories is based on certain relations obtaining between the suggester and the suggestee. Prestige, for instance, is an often-quoted explanatory concept in this connexion; rapport and transference are two other relations which have frequently been suggested. Sometimes an explanatory concept from this second group of theories is combined with one taken from the first group; the relation of prestige may be combined with the submissive instinct, for instance, as was done in McDougall's theory (1926), and so on.

A third type, the ideomotor theory, has lost much of the hold it once gained through William James' brilliant advocacy (1902). According to this theory, the idea of a motor act tends to be followed directly and without fail by the execution of that act, through some direct, reflex kind of connexion. This view was advanced more particularly by the advocates of the motor theory of thinking, and lost in favour because of the exaggerated claims of that school (Max, 1934; Gibson and McGarvey, 1937).

Only experimentation can decide between the claims of these three groups of theories, and a variety of tests of suggestibility have been used by research workers in this field. Often these tests are simply quantifications of familiar clinical tests; sometimes they are more original, such as Binet's *Progressive Lines* and *Progressive Weights* tests (1900). The question immediately arises as to whether all these tests measure the same thing, i.e. whether tests designed on *a priori* grounds to measure suggestibility actually succeed in doing so, and whether suggestibility is one definite, general mental mechanism which remains constant in any one person, or whether there are different kinds of suggestibility, measured by different kinds of tests.

In a research involving eight standard tests of suggestibility, I showed that these tests fell into two sharply distinguished groups; in other words, that they measured two essentially different kinds or types of suggestibility (1943). These two kinds of suggestibility were called "primary" and "secondary". Secondary suggestibility was exhibited in tests of the Binet kind, i.e. *Progressive Lines* and *Weights*. In these tests, a suggestion is conveyed to the subject that certain weights or lines, which are objectively equal, differ in weight or length, and his suggestibility is measured by the extent to which he shows himself amenable to this suggestion. Both direct, personal suggestion and indirect, impersonal suggestion can be used in this test.

Primary suggestibility was exhibited in tests such as the *Chevreul Pendulum* test, the *Arm Levitation* test, and the *Body Sway* test. In these tests the subject is told, either once or repeatedly, that a pendulum which he is holding will swing to and fro, that the arm which he is holding out sideways will move up or down, or that while he is trying to stand perfectly still, with his eyes closed, he will fall forward or backward. The actual movements resulting from these various suggestions are measured by suitable recording devices, and the maximum amount of movement consequent upon the suggestion is taken as the subject's score on the test. It is this type of suggestibility with which this paper is concerned, because it is related very closely to hypnosis (White, 1930; Jenness, 1933; Hull, 1933). In particular, the *Body Sway* test was subjected to a good deal of experimentation: a person who sways very much in this test, or who falls altogether, will nearly always fall into a hypnotic sleep very easily, while a person who remains entirely unaffected by this test will almost certainly remain unaffected by the hypnotist. The *Body Sway* test, therefore, enables us to answer questions which are of crucial importance for any theory of suggestibility and hypnosis. If, for instance, suggestibility is due to an individual's hysterical constitution, and therefore to his tendency to dissociation, as Janet (1907) maintained when he said: "Suggestibility . . . presents itself only with hystericals, and inversely, all hystericals present this same phenomenon in a higher or lower degree"—then if we test a number of hysterics on the one hand, and a number of people free from any signs of hysteria on the other, the two groups should be differentiated very definitely by the amount of sway they show in response to the suggestion. When I carried out this experiment, thirty non-hysterical men and women were found to be as suggestible as thirty men and women with pronounced conversion hysteria. (A number of cases of dysmnestic hysteria were also tested, but were not



above posture and movements with "congenital athetosis". O. Foerster (1921) has given a classical description of the motor behaviour of these athetotic patients and the illustrations in his article have remarkable resemblances to what is seen in hypoglycæmia. Foerster's theory that the inability of his patients to sit, stand or walk, and their grasping and climbing movements are a regression to anthropoid or simian forms of behaviour fits even better to the hypoglycæmic hyperkinesia because the movements here are much more dextrous and adroit. The site of the lesion in congenital athetosis is the striatum which normally controls the phylogenetic older pallidum. Before this control is established the human infant is a grasping climbing pallidum-preparation. The patient with "athétose double" remains so all his life because his striatum does not mature. Hypoglycæmia produces a regression to this stage by means of a reversible disturbance, obviously because the pallidum is more resistive to hypoglycæmic anoxia than the striatum.

That the climbing movements in hypoglycæmia are more dextrous is, however, an important difference: Motor behaviour of athetotic patients and of the newborn infant consists mainly of clumsy mass movements lacking in refinement and nimbleness; in comparison the hypoglycæmic hyperkinesia appears graceful and differentiated and is certainly not a mass movement. This points to the motor cortex which is evidently not completely out of function. It has with the loss of consciousness given up its leading and directing role, but it takes part in the functional unit of grasping and climbing as it probably does in the oral-facial syndrome.

I thankfully acknowledge the advice and criticism of Dr. P. K. McCowan, Physician Superintendent of Crichton Royal.

[The paper was followed by a cinematograph demonstration.]

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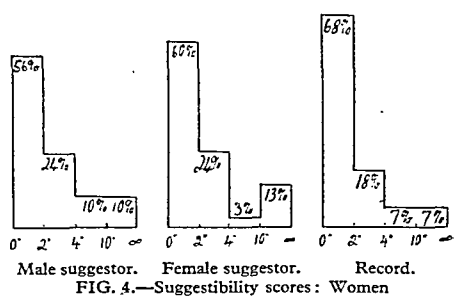
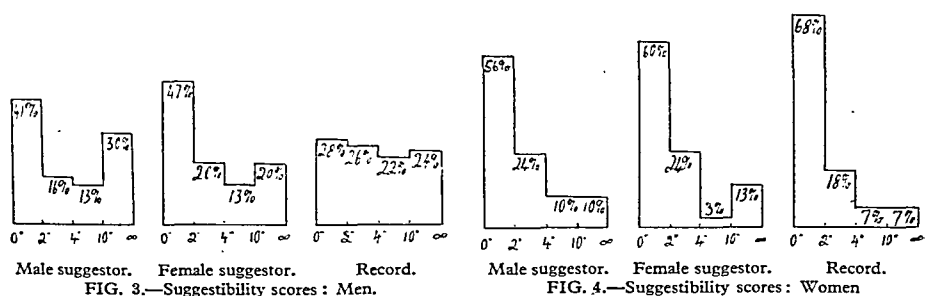
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Dr. E. STENGEL: The picture of the condition produced by high doses of insulin would be incomplete without a description of the disorders of speech associated with phases of altered consciousness during the hypoglycæmic state. The speech disorders associated with hypoglycæmia which I observed with Dr. Mayer-Gross at the Insulin Department of the Crichton Royal, Dumfries, can be divided into two groups. The one comprises disorders of speech before and after coma. The speech disorders during these phases do not differ materially from those associated with other states of clouded consciousness, such as delirium, epileptic twilight states and post-traumatic confusion. They can be observed best in those cases in which the clouding and clearing of consciousness take place gradually. We observed: (1) Echolalia. (2) Perseveration. (3) Paraphasias resulting from perseverations. Disturbance of word finding. In many cases the names of parts of the body disappeared last and returned first—the same words which are the first to appear in the normal development of speech. Echolalia is another feature which regularly occurs in the early speech development. The evolution of speech (H. Jackson, *Sel. Writings*) as consciousness returns therefore follows the same course as normal development. The appearance of those infantile features of speech goes parallel to the general behaviour of the patients who show extreme dependence and helplessness as consciousness returns.

The other group of phenomena comprises more primitive products of speech observed during the coma. Speech no longer serves as a means of "symbolic formulation and expression". However, the patients are not wordless, not noiseless. Speech, if there is any, is reduced to primitive emotional language such as swearing, singing. Even more primitive inarticulate ejaculations may take the form of shouting, howling, groaning and baby-like sounds, sometimes uttered rhythmically. In the majority of cases those utterances coincided with clonic movements of the facial muscles and the upper extremities, which were usually more marked on the right than on the left side, and were of the same type as those observed in *epilepsia partialis continua*. Their epileptoid nature was proved by the fact that they often were the forerunners of a major epileptic fit. They differed from other movements which obviously belonged to the extrapyramidal type of hyperkinesia. The primitive utterances and the clonic movements described were related, and appeared to be due to the same cerebral mechanism. Some of the cries produced by the patients in insulin coma and associated with clonic movements of the muscles of the face and the arms were similar to the well-known cry at the onset of a major epileptic fit; the generally accepted assumption that the epileptic cry is of purely respiratory nature should be re-examined. Observations during insulin coma and in other artificially produced epileptic states give rise to the suspicion that it may be of central rather than of peripheral mechanical origin. The next stage in the process of retrogression towards primitive reactions is the one characterized by oral reflexes, which Dr. Mayer-Gross has shown in his films. In that phase of deepest coma there is no speech at all.

phone record played over a pick-up relay by a nurse or by a patient. A similar programme of testing was arranged for 160 women; 30 were tested by me in person, 30 by the young lady, and 100 by means of the record. This record was made by me, and copies of it are obtainable from Mill Hill Emergency Hospital.

The results of this experiment are set out in figs. 3 and 4, for males and females respec-

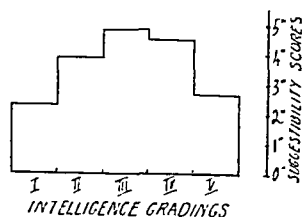


tively. It will be noticed that the differences between the three ways of inducing suggestibility are very small; on the average a male suggestor, a female suggestor, and a record produce much the same amount of sway. In Table II are given the data for the various groups, recorded in the form of "average sway in inches"; these figures show clearly that the record on the whole is almost exactly as successful as I am in person, while for both men and women the young lady is slightly less successful.

It should be noted that while for the men the record is more successful than either male or female suggestor in person, the record is less successful for the women than either male or female suggestor. This seems to indicate that while on the whole the personal relationship is not essential for the induction of suggestibility, such relationship is an aid to suggestibility in the case of women. It should also be noted that there are no such intersex effects as the theory of transference would make plausible; the female suggestor is slightly less successful with both the men and the women in roughly the same proportion. This shows that the sex of the experimenter plays little or no part in the induction of suggestibility. On the whole, then, our results tend to argue strongly against any type of prestige or transference theory.

Ignorance, credulity and stupidity have been at times cited as accounting for suggestibility (Janet, 1927). Hull (1933) on the other hand concludes a survey of experiments by stating that the relation between intelligence and suggestibility is positive. Neither view is borne out by the facts. Table III shows the average sway in inches on the Body Sway test of patients who were found to be in Grades I to V on the Matrices Perceptual Test of Intelligence. The very intelligent (Grade I) and the very dull (Grade V) sway on the average only about half as much as do those of average intelligence (Grade III). This curvilinear relationship between intelligence and suggestibility is brought out quite clearly in fig. 5. Again, experimental findings discredit the theory the experiment was designed to test.

TABLE III.		
Intelligence	Fall in inches	Number tested
Grade I	2.3	28
Grade II	3.9	76
Grade III	4.8	124
Grade IV	4.5	74
Grade V	2.7	18
Average	4.2	320



The last theory to be tested was the ideomotor theory. According to this theory, there exists a tendency of a certain strength for every motor idea to be carried into execution. It is this tendency which is being measured by such tests as the *Body Sway* test. We can subject this view to an experimental test in the following way. One group of 30 men was tested, and immediately retested. A second group, consisting of 40 men, was tested and retested the next day. A third group of 30 men was tested and retested after four weeks' stay in hospital. Similarly, three groups of altogether 100 women were tested and retested immediately, after one day, and after four weeks. There is no reason to suppose that stay in the hospital would make any difference to the strength of the

included in the above group because Janet's definition of hysteria would not cover them; they also were found to be no more suggestible than the non-hysterical group.) Other tests of suggestibility were also given to these groups, all of which tended to bear out the conclusion that hysterics are not markedly more suggestible than are non-hysterical neurotics (Eysenck, 1943). Consequently, Janet's theory found no support in this investigation. This conclusion is well in line with other studies which failed to find any correlation between "tendency to dissociation" and suggestibility (Messerschmidt, 1927; Mitchell, 1932).

The next theory to be considered is McDougall's view that suggestibility is connected with the "instinct of submissiveness". If this were correct, women should prove more suggestible than men on the average, because, as he also maintains, women tend to be more submissive on the whole. Fig. 1 shows the distribution of scores on the Body

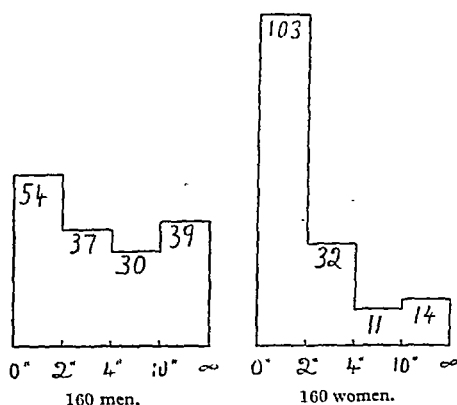


FIG. 1.—Suggestibility scores.

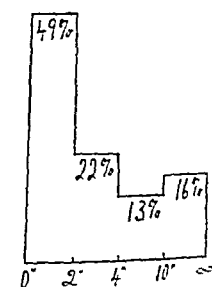


FIG. 2.—Total distribution—320 suggestibility scores.

Sway test of 160 male and 160 female neurotics, tested at Mill Hill Emergency Hospital. (Both the men and the women were very largely army patients.) The base-line of the diagrams is divided into four parts, in accordance with the maximum amount of sway noted. The first division contains cases swaying less than 2 in.; the next division those who swayed between 2 and 4 in. The third division contains the cases swaying between 4 and 10 in., and the last division cases swaying more than 10 in., or falling outright. (Those falling outright are recorded by means of the infinity sign =  $\infty$ .) The absolute numbers of cases falling into each of these divisions are given in the diagram.

If we call all those subjects who sway more than 2 in. suggestible (this value is of course arbitrary, and probably slightly underestimates the number of subjects showing suggestibility), we find the following percentages of men and women to be suggestible (Table I).

TABLE I.

160 male neurotics	...	...	66% $\pm$ 4% S.E.
160 female neurotics	...	...	36% $\pm$ 4% S.E.
320 neurotics	...	...	51% $\pm$ 3% S.E.

TABLE II.

		Sway in inches		
		Men	Women	Average
Male suggestor	...	5.5	3.3	4.4
Female suggestor	...	4.4	2.9	3.7
Record	...	5.8	2.8	4.3
Average		5.5	2.9	4.2

These figures show that roughly two-thirds of the men are suggestible, while only one-third of the women are suggestible according to our criterion. This difference is definitely statistically significant and shows that contrary to McDougall's theory *women tend to be less suggestible than men*. A theory which may account for this sex-differentiation will be suggested presently. Of all the 320 patients tested, almost exactly one-half were suggestible. The total distribution of our cases is shown diagrammatically in fig. 2.

Next we may test the various prestige and transference theories, all of which are based fundamentally on the face-to-face relation of experimenter and subject, and usually invoke a reinstatement of infantile attitudes inappropriate to the situation. These attitudes may or may not have a sexual basis, depending on the exact variant of the theory which may be held. If it can be shown that the person and the sex of the experimenter has little influence on the success of the experiment, and may in fact be quite irrelevant, these theories must lose much of their superficial plausibility.

The following experiment was arranged to test this hypothesis. Group A, consisting of 30 men, was tested by me in person. Group B, consisting of 30 men, was tested by a young lady at the hospital. Group C, consisting of 100 men was tested by means of a gramophone.

gestible than women on this test. It has been shown that men show more frequently the motor type of imagery, while women tend to be visiles and audiles (Brittain, 1907). Consequently men should on the whole have a stronger tendency to fall, and assuming that the power to inhibit such tendencies is equally divided between the sexes, men should actually show a greater average fall than women.

There can be little doubt that this tendency to fall is nearly always counterbalanced by an inhibition arising from the higher brain-centres. On questioning the patients after the experiment, it is found that they nearly always try to counteract the suggestion; they "fight against it", as they usually put it. The only ones who do not fight against the suggestion are those who are not at all affected in the first place, i.e. those who show no sign of ideomotor action. They feel no urge to fall, and consequently need not inhibit any movement.

This theory that suggestibility is the resultant of two forces, ideomotor action and inhibition, can be subjected to a crucial experiment. If a number of suggestible and of non-suggestible subjects are given a drug, such as scopolamine hydrobromide, which inhibits the action of the higher brain centres, then on retesting them we should expect two things to happen. In the first place, we should expect that those who were suggestible in the original test would prove even more suggestible now, since the drug has the effect of lessening the inhibitive power of the higher brain centres. Secondly, we should expect that those who in the first place showed no effect of the suggestion would still show no effect, as in the absence of any ideomotor tendency the degree of inhibition is immaterial to the outcome of the experiment. In carrying out this experiment, Baernstein (1929) found that suggestible subjects tended to become significantly more suggestible after being given the drug, while non-suggestible subjects remained unaffected. Consequently, we may consider our theory confirmed in this important corollary.

We can now see why hospital treatment should lead to a reduction in the amount of sway of neurotic soldiers. It is reasonable to assume that treatment will result in an increase of control of the higher brain centres over the motor mechanism—at least in those cases where treatment is partly or wholly successful—and consequently in an increase in the effectiveness of inhibition.

The explanation of the curvilinear relation between intelligence and suggestibility is less obvious. It is reasonable to assume that high intelligence will go, on the average, with more control of the higher brain centres over the motor mechanism. Conversely, we must assume that ideomotor action is less strong in the very dull—though why this should be so is by no means clear. Here we have a wide field where much experimental work could with advantage be done.

If our theory be true that a person's score on the *Body Sway* test is the product of two relatively independent forces, viz. ideomotor action and inhibition, then clearly the test as used at the moment is not a good test. No test which reports only the product of two independent forces, but does not give us any indication as to the relative part played by these forces, can be considered acceptable. Future work, therefore, must be directed towards measuring at least one of these two factors, aptitude and attitude, separately; if we know, for instance, the relative strength of the ideomotor component, as well as the result of the product (ideomotor action times strength of inhibition), then we can determine within very narrow limits of error the other factor, viz. strength of inhibition. It is clearly possible to measure separately the strength of ideomotor action by means of an extension of the Jacobson technique, i.e. of recording muscle currents by means of the string-galvanometer; consequently we may hope in time to achieve independent measurements of the components of *Body Sway* suggestibility.

Thus far I have dealt only with suggestibility. But although I believe that hypnosis can be understood only through its relation with suggestibility, I also believe that we must posit some principle of "progressive" or "cumulative" suggestibility if we want to understand hypnosis. In other words, if we want to transform simple suggestibility into that form of heightened suggestibility which we call hypnosis, we need some kind of mechanism which will "step up", as it were, or amplify this original basic suggestibility. This mechanism, I think, is to be found in the central nervous system, and can be explained with reference to the properties of the synaptic nerve junctions, in conformity with McDougall's well-known theory (1908).

According to this theory, the resistance of a synapse is inversely proportional to the current passing through it. Hypnotic suggestion restricts the field of consciousness by means of the mechanisms which we have discussed, thus directing the whole force of the available nervous energy through a smaller number of nervous channels. This automatically reduces the synaptic resistance in these channels, thus in its turn facilitating the passage of the nervous energy. This reciprocal reinforcement would account satisfactorily for the heightening of suggestibility which is found in hypnosis.

Many psychologists are inimical to any type of physiological theory, because physio-

ideomotor tendency; on the other hand, it would make a great deal of difference to the attitude and mental health of the patient. If then the retests show that stay in hospital does not influence the retest fall of our subjects, we may regard this result as favouring the ideomotor theory; if there is a marked difference, however, the results would require an alternative explanation.

The results are set out in Tables IV and V. The average fall (in inches) in the original test is given in brackets; also given in each case are the average fall in the retest, the ratio initial test/retest, the average difference between the subjects' sway on the initial test and on the retest (corrected for group trends, i.e. test/retest differences), and lastly this difference expressed as a percentage of the average total sway.

TABLE IV.

	Immediately	Retests : Men	
		After one day	After four weeks
Average fall ...	(4.7") 4.7"	(4.0") 3.6"	(5.2") 3.7"
Test/retest ...	1.0	1.1	1.4
Average diff. ...	1.6"	1.9"	2.0"
Diff. as % of fall	34%	53%	45%

TABLE V.

	Immediately	Retests : Women	
		After one day	After four weeks
Average fall ...	(2.3") 2.2"	(1.8") 1.8"	(2.5") 1.5"
Test/retest ...	1.0	1.0	2.1
Average diff. ...	0.4"	0.3"	0.6"
Diff. as % of fall	17%	17%	33%

The results show (1) that the reliability of the test is affected to some extent, but not as much as might have been expected, by the passage of time, and (2) that the difference in average amount of sway from test to retest is negligible when the test is repeated immediately or after one day, but that it is very considerable after four weeks' stay in hospital. This is true of men and women alike. This result, then, requires some alternative explanation to the ideomotor theory; we must in some way account for the fact that an improvement in the condition of the patient is accompanied (or followed) by a tendency to be less suggestible.

Having shown that none of the theories examined can account for the experimentally obtained evidence, we may pause and consider another body of evidence, viz. introspections of both patients and trained psychologists to whom this test was given. When this is done, it becomes apparent that we must take into account two factors, both of which determine the outcome of our experiment. These two factors are *aptitude* and *attitude* (cf. Eysenck, 1943).

People differ greatly in aptitude. Some subjects do not experience the least urge to fall forward when they are told that they are falling forward; others experience an almost irresistible urge to fall. This aptitude appears to be distributed roughly in accordance with the normal probability curve. But aptitude alone is not sufficient to account for the results of our experiments. Some patients of great aptitude clench their fists, shake their heads vehemently while the suggestion is going on, and may even audibly say: "No, no!" They are thus able to control to some extent their tendency to fall, and may only sway a few inches, or may even sway backwards. Others fall quite easily, without struggling overmuch. But attitude alone, again, is powerless without aptitude. Many patients whose attitude is highly positive are found hardly to sway at all, while others, with a very negative attitude, may fall altogether.

We have, then, the following picture: First, there is a tendency for the idea of falling forward, once it is introduced into the mind, to be carried into execution immediately—in conformity with the theory of ideomotor action. Secondly, this action may be inhibited by the higher brain centres. The outcome of this conflict is measured by our suggestibility score.

It is interesting to review the variety of ways in which the original idea can be implanted in the mind. We have seen that it can be done either by male suggestor, by female suggestor, or by means of a record. It can also be done, with similar effect, by unconscious imitation of someone reaching forward, by imagination of the act of falling, by autosuggestion, and by indirect heterosuggestion. In this last method, two experimenters talk to each other about the patient, who stands by with his eyes closed; they pass remarks such as: "I think he is falling forward, don't you?" and "There he goes—he is falling." It is possible by means of these indirect methods to cause the more suggestible subjects to fall outright.

In all these different ways, however much they may differ from traditional suggestibility experiments, ideas can be implanted in the mind of the subject, and will then seek to be translated into action. Jacobson has provided us with direct experimental proof of this ideomotor connexion (1929, 1932). He measured the action-currents in the muscles of the right arm while his patients were imagining that they were bending that arm, but under instruction *not actually to bend it*. He found definite evidence of action currents which continued as long as the patient continued imagining, and ceased immediately after. He found considerable variation in the strength of the action currents between different people, and concluded that motor impulses are at the basis of our imagery.

If this view be correct, we can explain quite simply the fact that men are more sug-

## Clinical Section

President—PHILIP TURNER, M.S.

[March 12, 1943]

### MEETING AT THE LONDON HOSPITAL

**Thrombocytopenic Purpura with Lymphocytosis.**—J. R. TASKER, M.B., B.Ch.

Mrs. A. T., aged 51.

*History.*—For twelve months—moderately severe epistaxes occurring every two months. Two weeks before admission: Noticed the appearance of bruises on her limbs without injury. Six days before admission: Onset of vaginal bleeding, although the menopause had occurred fifteen months previously at the age of 50. This continued until admission. Two days later: Recurrence of epistaxis, which persisted. Also noticed appearance of reddish spots over body. Previous health good. No family history of hæmorrhagic tendency. Patient had not taken any drugs or patent medicines recently.

*On examination.*—Healthy-looking middle-aged woman. Moderate pallor of mucous membranes.

Generalized petechial rash involving the skin, especially the extensor aspects of the limbs, and the mucous membranes. Many large bruises on the limbs. There was clotted blood in the nostrils and in the nasopharynx. Considerable vaginal bleeding.

Glands: Both groups of axillary glands were easily palpable, discrete, and non-tender. One slightly enlarged right supraclavicular gland.

Capillary permeability tests were negative. Liver and spleen were not felt.

*Investigations.*—Blood-count (on admission): R.B.C. 3,730,000; Hb. 70%; C.I. 0.94; W.B.C. 13,720 per c.mm. *Differential count*: Polys. 16.5%, small lymphos. 69.0%, large lymphos. 13.5%, large hyals. 1.0%. Platelets 18,650 per c.mm. Bleeding time 9 mins. 45 secs. Coagulation time 1 min. 44 secs. Red cell fragility: Hæmolysis to 0.4% saline.

Plasma ascorbic acid: 0.73 mg. per 100 c.c. Paul Bunnell test negative. Blood Wassermann reaction negative.

Sternal puncture: Showed active normoblastic erythropoiesis. 55% of the marrow cells were lymphocytes, 20% granular cells and their precursors, and 25% primitive red cells. The lymphocytes were mostly typical adult cells, and few primitive forms were seen. Megakaryocytes were plentiful and fairly numerous platelets were seen in the marrow films. The presence of active erythropoiesis, megakaryocytes and 20% of granular cells suggested that this was not the marrow of a case of lymphatic leukaemia.

Following admission to hospital the condition of the patient rapidly deteriorated owing to continued vaginal hæmorrhage and the occurrence of a severe melæna. Large retinal hæmorrhages appeared. Six days after admission blood-count showed R.B.C. 1,530,000 per c.mm.; Hb. 25%; C.I. 0.83; W.B.C. 31,840 per c.mm. *Differential count*: Polys. 26%, small lymphos. 60%, large lymphos. 11.5%, large hyals. 2%. transitional neutrophils 0.5%. Platelets 3,060 per c.mm.

The patient was treated with repeated transfusions of compatible blood with considerable improvement, her hæmoglobin rising slowly to 76%. But the thrombopenia and increased bleeding time persisted as did the enlargement of the lymphatic glands and the high lymphocyte count in the peripheral blood.

*Operation.*—Twenty-three days after admission splenectomy was performed by Mr. Alan Perry. The spleen was normal in size. Microscopic examination of a section of the spleen showed "lymphocytic hyperplasia of the Malpighian bodies. Great excess of lymphocytes in the sinuses of the pulp, much fewer in the solid strands of the pulp" (Dr. W. W. Woods).

Following splenectomy there was a dramatic improvement in the general condition of the patient, although she had a persistent slight fever for four weeks, for which no adequate cause could be found. There was no further hæmorrhage. The bleeding time fell to 2½ minutes while the platelet count rose to 571,000 per c.mm. The total leucocyte count fell post-operatively to 8,960 per c.mm. (34% small lymphocytes) but within three weeks had risen again to 22,760 per c.mm. (62.5% small lymphocytes). Both the raised lymphocyte count and the enlarged lymphatic glands then persisted until the patient was discharged, very much improved in general health, eight and a half weeks after admission.

logical events are even more speculative than are psychological happenings. But as Koehler points out (1942), we can test physiological explanations of psychological mechanisms by deducing certain consequences implied in the premises, and then conducting experiments to prove or disprove these deductions. One deduction which may be made from the premises of McDougall's theory is the following: Under hypnosis, there should be an improvement of various mental functions due to the greater concentration of mental energy in the relevant nerve channels. This improvement should be greatest in the simplest tasks, because there the concentration of energy is greatest due to its damming up in a very small number of channels, and least in very complex tasks, because there the sum total of nervous energy is distributed over a large number of channels, a condition not very different from that of waking life.

When testing this hypothesis experimentally, I found an average improvement in the hypnotic state over the normal of some 30% in thirty different tasks; for very simple tasks, such as tapping, dotting, &c., the improvement was in the neighbourhood of 70%, while for very complex tasks improvement was very small or even non-existent (Eysenck, 1939). In this important corollary, then, we find McDougall's theory confirmed. It should not be difficult to deduce various other corollaries from his premises, and by either confirming or disproving them show the essential correctness or incorrectness of his view.

The writer is indebted to the Rockefeller Foundation for a grant which enabled him to carry out the work described. He also takes pleasure in acknowledging permission by the Medical Superintendent to use clinical material at Mill Hill Emergency Hospital, and in thanking the medical staff of the hospital generally for their generous co-operation.

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Dr. J. A. HADFIELD: Many of the conclusions drawn by Dr. Eysenck are justified, but in other cases the conclusions drawn go beyond what the facts warrant. Taking "transference" as an illustration: the mere fact that a man or woman gives the suggestion does not necessarily imply a transference; it may be quite as impersonal as the gramophone record, which indeed produced the same results. But the experiment does prove something; for, if the suggestions are impersonal, the fact that suggestibility was produced disproves the Freudian theory in so far as it asserts that all suggestion is due to transference. A distinction must be made between suggestion and suggestibility: suggestion is the process of transmission (as in McDougall's definition), whereas suggestibility is the state of mind which makes the subject receptive to suggestion (as emphasized in Freud's definition). In the "transference" test, the suggestion is given, but the lack of suggestibility in the patient may induce indifferent results. An individual may be suggestible to one person and not to another; he may be suggestible to one theme and not another, or he may be only partially suggestible. The same criticism therefore applies to the experiments designed to prove that hysterics are no more suggestible than others. The hysteric may respond to indifferent suggestions like swaying, but may be no more suggestible to these indifferent tests than others; but since the hysteric has a tendency to resort to illness as a means of getting sympathy and an escape from responsibility, a suggestion of illness will be responded to far more readily than in the case of another man in whom it would have no effect, since he does not happen to be suggestible to that subject. The experiment therefore is not a true test of the point at issue.

The tests do prove, however, that the hysteric is not universally suggestible to any form of suggestion: he is only hypersensitive to suggestions corresponding with his tendency of mind.

The scope of these tests is very limited, and to claim that they abolish the theories of Janet, McDougall, James and Freud at one fell swoop is to put too great a strain upon our logic. Nor can I bring myself to believe that the theory put forward explains all the many facts of hypnosis, such as its physiological effects like the absence of bleeding during the hypnotic state, the hypersensitivity to time, and post-hypnotic phenomena.

It would be extremely valuable if Dr. Eysenck in his experiments could discover some simple and more certain method of producing deep hypnosis. Not only is hypnosis of great therapeutic value for suggestion, but it is easily the best form of anaesthetic, and under its influence we should be able to make many experiments throwing light on the relations of mental and bodily processes, including the psychosomatic disorders.

*On examination.*—Gross exophthalmos. Pale; dry skin, deficient hair and a malar flush. There was no enlargement of the thyroid despite his statement. Blood-pressure 110/80. Fundi normal.

Blood-count: R.B.C. 3,480,000; Hb. 72% (Haldane); W.B.C. 8,000 (polys. 61%, lymphos. 24%, hyals. 13%, eosinos. 1%, basos. 1%). B.M.R. -20.

X-rays of the skull showed the pituitary fossa slightly enlarged but X-rays of the long bones and epiphyses showed no abnormality. He was unable to tolerate thyroid gr. 1 t.d.s. and was, therefore, treated with a course of injections of antuitrin S but these produced no benefit.

On 31.4.41 he was admitted to hospital complaining of two weeks' severe colicky pain in the right side of his back radiating to the right groin, together with nausea and vomiting. The urine contained a few white cells, amorphous phosphates and *B. coli*. Blood urea 56 mg. %.

X-rays of renal tract and intravenous pyelogram showed a calculus in the lower end of both ureters. Both stones were passed.

He has continued to attend the out-patients' department and has been well on thyroid gr. ½ mane which he has tolerated. He has not grown or gained weight but his hæmoglobin has gradually risen to 100% (Haldane) and his B.M.R. is now +5.

Dr. RUSSELL BRAIN: In this case exophthalmos is associated with myxædema. There is evidence that in myxædema there is an excess of the thyrotrophic hormone of the pituitary in the blood and urine and this seems the most probable explanation of the exophthalmos.

#### Elliptocytosis Associated with Hereditary Hæmorrhagic Telangiectasia.—J. M. LIPSCOMB, M.B.

Two cases, brother and sister, from a family in which a chance association of oval red cells with hereditary telangiectasia has been demonstrated.

(1) S. H., female, aged 26. Three attacks of jaundice, the latest during 1942 when admitted to the London Hospital for a gynaecological condition. At that time was jaundiced and spleen was palpable. Oval cells plentiful with evidence of hæmolysis and regeneration. Minute telangiectases on hard palate and alveolar margin and a few on lips.

(2) L. H., male, aged 24. Frequent epistaxis and, in 1941, severe hæmoptysis. Full investigations including bronchoscopy revealed no cause.

1942: Sudden attack of severe gripping pains in chest with electrocardiographic changes suggestive of pericardial condition (? hæmopericardium).

1943: Sudden epileptiform seizure; admitted to hospital with clonic jerking involving whole of left side of body; clonus passed off leaving left-sided hemiplegia which completely recovered. Blood showed polycythæmia, abundant oval cells and evidence of increased hæmolysis. Spleen palpable. Small telangiectasis has been seen on nasal septum.

[April 9, 1943]

#### MEETING AT ROYAL CANCER HOSPITAL (FREE), LONDON

##### Case of Hepatomegaly (Nature Undetermined).—REGINALD C. B. LEDLIE, F.R.C.S.

S. B., female, aged 36.

*Previous history.*—1927: Rheumatic fever—restricted exercise for one year. 1941: Appendicectomy. No history of dysentery. Amenorrhœa since the age of 30.

*Present history.*—June 1942 admitted to Royal Cancer Hospital complaining of pain in the right lower chest and hypochondrium of one month's duration. The pain occurred in attacks lasting ten to twenty minutes several times each day. Slight aching between the attacks together with nausea and vomiting. The pain had no time relationship to food. There was no jaundice. Loss of weight 1 st. in a few months.

*Family history.*—One of eleven children. One brother had tuberculous peritonitis.

*On examination.*—General condition: Fairly well nourished. Mucous membranes good colour. Abdomen: Fullness in right flank and hypochondrium. On palpation a firm smooth mass occupying the right hypochondrium and extending to below the level of the umbilicus. Spleen not palpable. *Per vaginam*, retroverted uterus. *Per rectum*, no appreciable disease.

*Investigations.*—Blood-count: R.B.C. 5,270,000; Hb. 102%; C.I. 0.96; W.B.C. 7,000 (polys. 64.5%, lymphos. 27.5%, monos. 5.5%, eosinos. 1.5%, basos. 1.0%).

Wassermann reaction negative. Agglutination for typhoid and paratyphoid negative.

Urine: Culture *B. coli*.

Intravenous pyclogram: Although both kidneys function the right kidney is lying low



### Acromegaly, Partial Removal of Acidophil Adenoma of Pituitary Followed by Two Pregnancies.—IAN JACKSON, F.R.C.S., M.R.C.O.G.

**History.**—In July 1931 Miss V. S., aged 20, was referred to Mr. Hugh Cairns with acromegaly, complaining of disturbance of vision. For one year she had noticed her hands and feet getting larger and for the last four weeks she had blurred vision. Her periods began when she was 14, but had always been irregular. Amenorrhœa for seventeen months followed by one period four months ago.

**On examination.**—She had definite appearance of acromegaly; six diopters of myopia in both eyes, bilateral primary optic atrophy and a bitemporal hemianopia of scotomatous type. X-ray showed the sella turcica to be enlarged and there was tufting of the terminal phalanges.

**Operation** (July 20, 1931).—Partial removal of a cystic and solid pituitary tumour by the right transfrontal route by Mr. Cairns. Some difficulty was experienced on account of a pre-fixed chiasma.

Histological report (Dr. Dorothy Russell): Solid polygonal-celled (predominantly alpha-granule) adenoma of pituitary.

Following operation her visual acuity and fields greatly improved. Her feet became smaller but her hands remained the same. Married six weeks after operation. She had amenorrhœa following the operation but a year later was found to be pregnant. The Zondek-Aschheim reaction was positive at the 25th week; concentration below normal.

January 1933: Normal delivery of living girl, 7½ lb., under the care of Mr. Victor Lack. Complete amenorrhœa followed the labour until 1941 when she had six periods.

**APPENDUM.**—April 1943: Normal delivery of living boy, 8½ lb., under the care of Mr. Lack.

### Addison's Disease Treated by Implantation of Desoxycorticosterone Acetate Pellets.—K. M. A. PERRY, M.D.

L. T., male, aged 19. Admitted to hospital 17.2.41.

**History.**—For three months—lack of energy, fatigue and weakness. Lost 7 lb. in weight. Loss of appetite for the previous four weeks and vomiting for two days.

**Family history.**—Mother and father well, no siblings.

Pigmented frightened-looking lad with prominent eyes. All skin pigmented, particularly behind knees, axillæ, nipples and around umbilicus. Some patches of pigmentation in buccal mucosa and conjunctivæ. No palpable glands. Pulse soft, 84, regular. B.P. 60/40. Urine showed cloud of albumin. X-ray of chest and abdomen—no abnormality.

**Treatment.**—6 g. salt daily and 5 mg. of percorten until he had gained 1 st. in weight. Percorten and later doca pellets were implanted and he has remained fit and has worked as an A.R.P. ambulance driver.

Data of progress as follows:

Date	B.P.	Plasma chlorides (millimols = 585 mg.%)	Blood urea	Blood sugar	Hb. % (Haldane)	Weight
17.2.41	60/40	79 (453 mg. %)	232			8 st. 3 lb.
21.2.41	60/45				85	
25.2.41	85/55	106 (620 mg.%)	27	90	68	8 st. 10 lb.
7.3.41	80/55	102 (596 mg.%)	28	110	72	9 st. 1 lb.
7.4.41	105/55	103 (602 mg.%)	22	78	71	9 st. 3 lb.
22.5.41	108/70	300 mg. percorten pellets implanted.				
25.5.41	130/90	106 (620 mg.%)	22	77	86	9 st. 5 lb.
26.6.41	120/90	105 (614 mg.%)	45	50		9 st. 12 lb.
25.8.41	100/75					10 st. 2 lb.
16.10.41	85/60	E.S.R. 8	Mantoux (1 : 100,000) negative			10 st. 5 lb.
28.10.41	1,000 mg. percorten pellets implanted.					
30.10.41	90/70	99 (579 mg.%)	54	85		10 st. 9½ lb.
12.1.42	160/110					10 st. 6 lb.
30.3.42	166/120					10 st. 2½ lb.
4.6.42	135/90	103 (614 mg.%)	45	50		10 st. 2 lb.
24.8.42	120/90					
14.9.42	90/70					9 st. 10 lb.
12.10.42	80/40	1,000 mg. doca pellets implanted.				
7.12.42	140/110					10 st. 6 lb.
21.1.43	190/100	89 (515 mg.%)		21	100	11 st.
4.2.43	150/100					11 st. 4 lb.

### Congenital Myxœdema. Exophthalmos. Bilateral Ureteric Calculi.—K. M. A. PERRY, M.D.

B. C., male, aged 16. Underdeveloped boy; height 4 ft. 9½ in., weight 6 st. 5 lb.

**History.**—First attended 18.4.40. He complained that for six years he had noticed a swelling in the neck and prominence of the eyes. No palpitation. Appendicectomy at the age of 4. His sister had undergone a recent operation for thyrotoxicosis.

## Section of Obstetrics and Gynæcology

President—Dame LOUISE McILROY, D.B.E., M.D.

[January 15, 1943]

### DISCUSSION ON RADIOLOGICAL DIAGNOSIS OF DISPROPORTION

Professor J. Chassar Moir: (*Synopsis*). In some 450 obstetric cases radiological findings have been correlated with the course of subsequent or previous labours.

The lateral view of the pelvis is by far the most important of any single examination, both on its own account and because information obtained from it enables the patient to be correctly positioned for subsequent examinations. It is obtained with the patient standing erect and with the X-ray tube at  $4\frac{1}{2}$  ft. distance from the film. The technique has been greatly simplified by adding to the upright screening stand two wooden pegs against which the patient presses her anterior superior iliac spines (fig. 1). By this simple expedient three of the bugbears of lateral radiography are eliminated; the patient is maintained in a true lateral position, the X-ray tube is automatically positioned over the selected centre of the pelvis, and the patient remains motionless during exposure. A stand bearing a metal rod with centimetre markings is placed against the cleft of the buttocks. A scale, equally magnified with the pelvis is thus imposed on the resulting film.

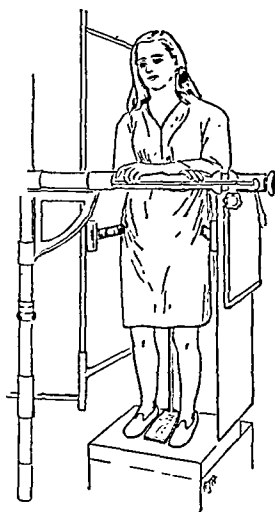


FIG. 1.—Lateral radiography. Patient presses the anterior superior iliac spines against 2 pegs. One of these is attached to the film-cassette holder and moves up and down with that holder. The other has an independent vertical movement to suit the height of the patient.

Details were also given of a modified technique used for examination of patients during labour. Radiographs to show the plan of the brim of the pelvis were obtained by Thoms's method; special precautions were described which ensured that the brim was parallel with the X-ray film. A simple form of pubic arch pelvimetry was also described.

Obstetric disproportion means the mal-relationship of foetal head and maternal pelvis. It is therefore of little avail to study the one without the other. Cephalometry presents many difficulties. Reece's contribution to the subject has been of help, but he has, perhaps, over-simplified the matter (Reece, L. N. (1935), *Proc. R. Soc. Med.*, 28, 489). By methods which were described a helpful estimate of the size of the head can be obtained in about 90% of cases. It is very seldom that the biparietal diameter of the foetal head exceeds the radiological estimation; any error of interpretation is usually in the direction of overstating the size of the head.

When the head cannot be directly gauged against the pelvic brim, as, for example, in breech presentation, cephalometry and pelvimetry assume a major importance. Even a slight degree of disproportion may then be a serious obstacle for moulding has no time to develop, and a misfit, if present, becomes evident when it is too late to avoid disaster.

Radiological examination cannot predict the amount of moulding that the head may undergo, and in interpreting the radiological findings an allowance of 2 to 3 mm. should be made for such alteration in shape. It must be remembered that moulding is safe up to a certain point, but after this it becomes a danger to the foetus. Moulding is surprisingly effective in overcoming the resistance offered by a rickety-flat pelvis for here the contraction is in only one dimension. It is less effective in overcoming the resistance offered by the generally contracted type of pelvis. Radiology, by revealing the pelvic type, shows, to some extent, when moulding is likely to be effective. On clinical grounds there is reason for believing that moulding is more dangerous in the case of the large head of a post-mature foetus than it is in the case of a soft head of a premature baby. In the case of the rickety-flat pelvis it is right and proper, unless disproportion is very considerable, to watch the effect of moulding; that is, in effect, the policy of "trial-labour". But when dealing with other varieties of pelvic contraction there is less room for enthusiasm regarding "trial-labour" at term; it should then be reserved for border-line cases of disproportion only.

and secretion is suppressed from above. The pelvis is distorted with partial obliteration of the upper and middle calyces. Retrograde pyelogram: (Right) shows normal kidney pelvis outline. Barium meal: Stomach and duodenum function normally. Cholecystogram: Numerous calcified shadows are seen in the liver area. The gall-bladder appears to fill on the left side of the spine.

*Progress.*—The patient developed pyrexia which responded to chemotherapy and was thought to be due to the *B. coli* infection of the urinary tract. Apart from this there was little alteration in the patient's condition.

*Treatment.*—Low fat diet.

Readmitted March 1943: Complaining of general lassitude, lack of interest and energy: Has discomfort when lying on the left side. Has been free from previous "attacks" since following low fat diet.

*Examination* as above. Abdominal girth unaltered.

*Reinvestigation.*—Lævulose tolerance test normal. Cholecystogram: On this occasion gall-bladder fails to function normally. Diastatic index: 13.3 units per c.c. Repetition of other investigations showed no alteration

**Primary Lymphoma.**—REGINALD C. B. LEDLIE, F.R.C.S., and D. W. SMITHERS, M.D., D.M.R.

B. D., female, aged 56.

*History.*—May 1942: Complaining of lassitude since an attack of influenza seven months previously. No other symptoms until eight weeks ago when patient developed flatulence, nausea and dull abdominal pain after food.

*Past history.*—1931: Panhysterectomy for menorrhagia ? due to fibromyomata.

*On examination.*—General condition fair. Rather thin and pallid. Lymphatic system: Chain of smooth discrete lymph nodes both sides of neck and similar nodes in both axillæ and both groins. Abdomen: Spleen enlarged to 4 fingerbreadths below the costal margin. Smooth mass palpable in the abdomen below the spleen. Liver not palpable.

*Investigations.*—Blood-count: R.B.C. 3,740,000; Hb. 69%; C.I. 0.93; W.B.C. 10,200 (polys. 16.5%, lymphos. 79.5%, monos. 4%). Wassermann reaction negative. Biopsy of lymph node left groin. Section: Suggestive of lymphoma or true blastoma of lymphoid tissue. Radiograph of chest: No abnormal masses.

*Treatment.*—June-July 1942. X-rays to spleen, abdominal mass, both sides of neck, axillæ and groins. Dose to each area from 750 r to 250 r in sixteen days. Integral dose 6.2 megagramme röntgens.

*Progress.*—X-ray therapy resulted in the disappearance of all glandular masses. The spleen regressed to 2 fingerbreadths below costal margin.

September 1942 in good health. No recurrence of masses.

February 1943 readmitted. General condition had deteriorated and gland masses in all areas previously affected had recurred. The spleen had increased in size. Since admission the liver has become palpable and has also increased in size.

29.3.43: Blood-count: Hb. 79%; W.B.C. 5,000 (polys. 36.5%, lymphos 50.5%, monos. 10%, eosinos. 2.5%, basos. 0.5%). No immature forms.

30.3.43: Biopsy of cervical node. Sections show the features of a primary lymphoma.

The patient is at present being treated by X-ray therapy.

**Carcinoma of the Maxillary Antrum Treated by Radium and Surgery.**—W. A. MILL, M.S., F.R.C.S., and M. LEDERMAN, M.B., D.M.R.E.

M. R., aged 52.

*History.*—October 1936: Patient first attended this hospital with nasal obstruction and unilateral nasal discharge of four months' duration. Swelling of left cheek also noticed—this had rapidly increased in size.

*On examination.*—Externally—marked swelling of whole of left side of face, proptosis, impairment of function of 4th nerve and diplopia. No other cranial nerves involved. Mouth: extensive non-ulcerated swelling on the left side of the hard palate. Nose: nodular, ulcerating mass completely obstructing the left anterior naris.

*Investigations.*—15.10.36: Biopsy from left naris showed undifferentiated carcinoma probably arising in mucous glands. Blood: Wassermann reaction negative.

*Treatment.*—17.10.36 to 21.11.36: Treated by 1 g. telerradium unit. Tumour dose 4,000 r in thirty-five days. 22.12.36: Fenestration and insertion of radium applicator. Dose 6,000 r in seven days.

*Subsequent history.*—Patient has remained well for over six years.

The present attitude is to reconstruct the foetal head if specific diameters are recognizable, and a two-dimension model of that head is made; otherwise standard models of a hypothetical full-term foetal head (e.g. circle of 3.8 in. diameter and an ellipse measuring 3.8 in. by 4.5 in.) are used: these models are then compared against the two-projection pelvic charts from inlet through the cavity to the outlet.

Before this approach was used, whilst it was easy to group cases into (i) those with no question of disproportion and (ii) those with insurmountable disproportion, in the border-line cases it was difficult to give a reasoned prognosis as to the likely course of labour and there was a tendency to adopt an unduly pessimistic outlook.

However, with the two-projection pelvic chart method it has been found that reasonably accurate forecasts of the course of labour have been made in the border-line cases.

In the paper as read and illustrated, the clinical and radiological records with the follow-up results were given in detail concerning 16 "border-line" disproportion cases out of a consecutive unselected series of 100 patients sent for pelvimetry.

It is felt that this method using two-projection reconstruction charts offers a reasonable basis on which to form conclusions as to the relative proportions of the pelvis and foetal head and that it is especially helpful in the border-line cases.

[The complete paper was illustrated by 50 slides and a ciné-film.]

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[February 19, 1943]

### A JOINT MEETING

of the

### Section of Obstetrics & Gynæcology with the Medico-Legal Society

was held on this date, when a Discussion took place on "Medico-legal Pitfalls in Obstetrical and Gynæcological Practice—excluding Abortion". A report of the Discussion will be published in the *Medico-Legal and Criminological Review*.

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[March 19, 1943]

**Carcinoma of Cervix Uteri; Wertheim's Hysterectomy; Tuberculosis of Regional Pelvic Lymphatic Glands.**—L. CARNAC RIVETT, M.C., F.R.C.S., F.R.C.O.G., and JANET BOTTOMLEY, M.D., F.R.C.S., M.R.C.O.G.

Mrs. R. P., aged 61, was admitted to hospital in September 1942, complaining of painless, slight vaginal bleeding, which had been intermittent for two months. Micturition normal. Bowels constipated, with occasional attacks of diarrhoea.

**Past history.**—1923: Subtotal hysterectomy and left salpingo-oophorectomy. Pathologist's report: Cystic endometritis; retention cyst of left ovary.

**Obstetric history.**—1914: Instrumental delivery of an infant weighing 9½ lb. No miscarriages.

**On examination.**—General condition good. Heart and lungs normal. B.P. 140/90. The abdomen showed a mid-line subumbilical scar. On vaginal examination, an irregular friable growth was found on the posterior lip of the cervix. There was no extension beyond the cervix, and no infiltration of the parametrium. (League of Nations' Classification: Stage 1.)

These findings were confirmed on examination under anaesthesia. Biopsy report: Squamous-celled carcinoma.

**Investigations.**—Hb. 88%; C.I. 0.9; W.B.C. 5,600 per c.mm.; blood urea 26 mg. per 100 c.c.; urea concentration, maximum 3.5%.

**Operation** (by L. C. R. 18.9.42).—*Wertheim's hysterectomy of cervical stump.*

**Anæsthetic:** Continuous pentothal in blood-drip transfusion.

**Findings:** Body of uterus and left adnexa removed previously. No peritoneal adhesions. No infiltration of growth beyond the cervix. The bladder stripped easily. No lymph glands were palpable on the left side of the pelvis. In the right obturator fossa there were several enlarged, soft glands. These were removed by dissection. No enlarged glands were palpable elsewhere in the abdominal cavity.

**Histology.**—Section of the cervix showed squamous-celled carcinoma. There was no evidence of tuberculosis in the cervix. The lymphatic glands from the right side of the pelvis showed no carcinomatous deposits. There were numerous epithelioid and giant cells, giving the typical appearance of active tuberculosis. There was no caseation. No tubercle bacilli were demonstrated by the Ziehl-Neelsen technique.

**Comment.**—From a study of the literature, coincident carcinoma and tuberculosis of

The biparietal diameter of the foetal head probably increases by 1 to 1.5 mm. weekly in the last month of gestation. Allowance must be made for this fact when examining the radiograph of the foetal head. This rate of growth is less than that mentioned by Reece.

It is comparatively easy to obtain measurements from various pelvic radiographs. It is far more difficult to judge their true meaning. Undoubtedly the conjugate of the brim is the most important of any single measurement. But it does not follow that if this measurement is generous the other pelvic measurements must also be adequate. In districts where rickets is not prevalent, the commonest cause for prolonged labour and for forceps delivery is a contraction of the pelvis at the level marked by the lower margin of the symphysis, the ischial spines, and the tip of the sacrum; contraction at this level is frequently combined with a narrowing of the pubic arch.

There are two methods by which the significance of the pelvic measurements can be better appreciated. One consists of making charts to show the shape and size of the cross section of the pelvic canal at the level of the brim, and at the level of the ischial spines. On these charts is superimposed an ellipse representing the estimated area of the flexed foetal head. It is then possible to get visual evidence of the space available for the foetal head and to appreciate the tightness of fit (Moir, J. C. (1941), *Edinb. Med. J.*, 48, 361).

The second method is to search for some relationship between the measurements of the head and of the pelvis that can be used to indicate the boundary between safety and possibility of danger. The nature of the problem is such that it is absurd to suppose that some magical formula can be found which will enable one to predict when the foetus will, and when it will not, be delivered by natural means. But that is not to say that a dividing line may not be distinguished on one side of which spontaneous safe delivery is highly probable, and on the other side of which danger of prolonged or difficult labour is present, and quickly increases as the dividing line is left behind. [Charts were shown bearing on this statement.]

There are various special indications for radiology in obstetrics. A woman who has had a difficult labour ending in the delivery of a dead baby may demand—not unreasonably—that her next shall be delivered by Caesarean section. Sometimes there is no obstetrical evidence that the operation is really necessary, and it is then a boon to have the benefit of a radiological examination of the pelvis. The best line of treatment can be decided in advance and often the examination is the means of dispelling anxieties that needlessly vex the patient's mind.

Radiology is only part of the examination of an ante-natal patient and cannot displace or supersede clinical examination. It can, however, fill a gap that sometimes remains after clinical examination. The fear is sometimes expressed that increased use of radiology will lead to increased and unnecessary surgical interference; this is possible when bad radiology is combined with bad obstetrics. It is also said that the radiologist will displace the obstetrician in deciding the manner in which the patient is to be treated. This criticism again supposes that the obstetrician has no ability of his own. In point of fact, the obstetrician's clinical judgment is bettered by his increased knowledge and the clearer mental picture he is able to form of the birth mechanism.

Dr. E. Rohan Williams (*Synopsis*). The technique and method for the study of disproportion to be described have been in use at Queen Charlotte's Hospital since 1941: the following radiographs are taken: (1) Stereoscopic antero-posterior pair (15 in. by 12 in.), centring 2 in. above the symphysis, patient supine. (2) Supero-inferior inlet projection, the pelvic brim being arranged parallel to the film. (3) Lateral projection. (4) Outlet projection, a modification of that described by Chassard and Lapine, with a 10° to 15° forward angulation of the tube.

Radiographs (2) and (3) are taken with an opaque plumb-bob suspended from the tube-filter so that the exact centring point is shown on the film: with this known centring point, true reconstruction outline charts of (a) the pelvic brim and (b) the mid-line plane of the pelvis (as seen in the lateral view) can be made using the method described by Gage (*Recent Advances in Obstetrics and Gynaecology*, Bourne and Williams, 4th Ed. 1939, 5th Ed. 1942, London). These charts show not only the true size but also the exact shape of the pelvis in two planes: superimposed on the inlet chart are placed the ischial spines.

By a similar reconstruction the foetal head can be charted: in certain cases, specific diameters are recognizable and accurate cephalometry may result, but though by stereometric methods what is seen in a radiograph may always be brought to its true size, it is far from easy to recognize specific diameters.

Whilst it is desirable to achieve an accurate cephalometry it is not of great importance because diametric presentations may be altered by moulding and the influence of soft tissues on rotation, flexion and extension of the head.

The present attitude is to reconstruct the foetal head if specific diameters are recognizable, and a two-dimension model of that head is made; otherwise standard models of a hypothetical full-term foetal head (e.g. circle of 3.8 in. diameter and an ellipse measuring 3.8 in. by 4.5 in.) are used: these models are then compared against the two-projection pelvic charts from inlet through the cavity to the outlet.

Before this approach was used, whilst it was easy to group cases into (i) those with no question of disproportion and (ii) those with insurmountable disproportion, in the borderline cases it was difficult to give a reasoned prognosis as to the likely course of labour and there was a tendency to adopt an unduly pessimistic outlook.

However, with the two-projection pelvic chart method it has been found that reasonably accurate forecasts of the course of labour have been made *in the border-line cases*.

In the paper as read and illustrated, the clinical and radiological records with the follow-up results were given in detail concerning 16 "border-line" disproportion cases out of a consecutive unselected series of 100 patients sent for pelvimetry.

It is felt that this method using two-projection reconstruction charts offers a reasonable basis on which to form conclusions as to the relative proportions of the pelvis and foetal head and that it is especially helpful in the border-line cases.

[The complete paper was illustrated by 50 slides and a ciné-film.]

[February 19, 1943]

## A JOINT MEETING

of the

### Section of Obstetrics & Gynæcology with the Medico-Legal Society

was held on this date, when a Discussion took place on "Medico-legal Pitfalls in Obstetrical and Gynæcological Practice—excluding Abortion". A report of the Discussion will be published in the *Medico-Legal and Criminological Review*.

[March 19, 1943]

**Carcinoma of Cervix Uteri; Wertheim's Hysterectomy; Tuberculosis of Regional Pelvic Lymphatic Glands.**—L. CARNAC RIVETT, M.C., F.R.C.S., F.R.C.O.G., and JANET BOTTOMLEY, M.D., F.R.C.S., M.R.C.O.G.

Mrs. R. P., aged 61, was admitted to hospital in September 1942, complaining of painless, slight vaginal bleeding, which had been intermittent for two months. Micturition normal. Bowels constipated, with occasional attacks of diarrhoea.

**Past history.**—1923: Subtotal hysterectomy and left salpingo-oophorectomy. Pathologist's report: Cystic endometritis; retention cyst of left ovary.

**Obstetric history.**—1914: Instrumental delivery of an infant weighing 9½ lb. No miscarriages.

**On examination.**—General condition good. Heart and lungs normal. B.P. 140/90. The abdomen showed a mid-line subumbilical scar. On vaginal examination, an irregular friable growth was found on the posterior lip of the cervix. There was no extension beyond the cervix, and no infiltration of the parametrium. (League of Nations' Classification: Stage 1.)

These findings were confirmed on examination under anaesthesia. Biopsy report: Squamous-celled carcinoma.

**Investigations.**—Hb. 88%; C.I. 0.9; W.B.C. 5,600 per c.mm.; blood urea 26 mg. per 100 c.c.; urea concentration, maximum 3.5%.

**Operation** (by L. C. R. 18.9.42).—*Wertheim's hysterectomy of cervical stump.* Anaesthetic: Continuous pentothal in blood-drip transfusion.

**Findings:** Body of uterus and left adnexa removed previously. No peritoneal adhesions. No infiltration of growth beyond the cervix. The bladder stripped easily. No lymph glands were palpable on the left side of the pelvis. In the right obturator fossa there were several enlarged, soft glands. These were removed by dissection. No enlarged glands were palpable elsewhere in the abdominal cavity.

**Histology.**—Section of the cervix showed squamous-celled carcinoma. There was no evidence of tuberculosis in the cervix. The lymphatic glands from the right side of the pelvis showed no carcinomatous deposits. There were numerous epithelioid and giant cells, giving the typical appearance of active tuberculosis. There was no caseation. No tubercle bacilli were demonstrated by the Ziehl-Neelsen technique.

**Comment.**—From a study of the literature, coincident carcinoma and tuberculosis of

the female generative tract appears to be uncommon. Few of the records refer to the lymphatic glands. In 37 recorded cases, carcinoma was present in the cervix in 21, in the body of the uterus in 13, and in the tubes in 3. In these 37 cases, tuberculosis was present in the cervix in 6, in the body of the uterus in 22, and in the tubes, peritoneum or lymph glands in 9. In only a small proportion of the cases were tubercle bacilli demonstrated.

It is possible that tuberculosis is present in cases of carcinoma more frequently than is suspected, as the widespread use of radium in the treatment of carcinoma of the cervix means that in only a small proportion of cases are the glands examined histologically. However, Bonney in a series of over 500 Wertheim operations has not seen a case in which tuberculosis of the pelvic lymphatic glands was present.

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## Placenta Prævia and Accreta.—IAN JACKSON, F.R.C.S., M.R.C.O.G.

Mrs. A. B., aged 37. Previous pregnancies—1934: Forceps delivery of 7¾ lb. girl at 40 weeks. Prolonged third stage followed by manual expression of placenta. 1938: Spontaneous delivery of 10½ lb. boy. Severe post-partum hæmorrhage. Transferred to hospital where she had a blood transfusion followed by manual removal of a large placenta. Puerperal sepsis for ten weeks and diarrhœa.

Her periods have always been normal, but she has not had one since 1938. When examined in January 1942 the body of the uterus was said to be smaller than normal.

This present pregnancy was normal until 40 weeks when the head could not be made to engage in spite of no bony disproportion. The patient was admitted to hospital and vaginal examination with aseptic precautions revealed a central placenta prævia. The vagina was packed, the patient's blood group ascertained and operation proceeded with at once.

A classical Cæsarean section was performed under intravenous pentothal anaesthesia and an 8½ lb. baby was delivered. The uterus was firmly contracted but the placenta did not separate. An attempt was made to remove it with the fingers but this was found to be impossible, and there was severe bleeding. A diagnosis of placenta accreta was made and total hysterectomy performed. The patient was given a blood transfusion and made an uneventful afebrile recovery and was discharged at the end of three weeks. The patient never lactated.

A painting of the uterus was shown noting the central placenta prævia, thinning of the lower uterine segment, and a small separated upper portion. A microscopic lantern slide showed penetration of trophoblast and villi into the myometrium, thinning of the myometrium, deficient decidua basalis, and absence of the fibrin layer of Nitabuch.

*Comment.*—As is usual in these cases the patient was a multigravida. Irving and Hertig found that 16 of the 86 cases described in the literature had had a previous manual removal of placenta. Damage may be done to the lining of the uterus during manual removal or with the subsequent infection, but it is more probably a primary factor, endocrine in origin which causes a deficient decidua. There was possibly partial destruction of the anterior lobe of the pituitary associated with the severe post-partum hæmorrhage. She had amenorrhœa and when examined four years later the body of the uterus was smaller than normal and there was no lactation following the hysterectomy. It is possible that this also caused underdevelopment of the decidua predisposing to a placenta accreta. I have found four cases of associated placenta prævia and accreta in the records of the London Hospital, and there have been at least 15 cases reported in the literature.

If it is impossible for the fingers to find a plane of cleavage during a manual removal of placenta, a diagnosis of placenta accreta should be made. The uterus may be packed, blood transfusion given and abdominal hysterectomy performed.

A more accurate classification of retained placenta should be put in records and reports as it is only in this way that we will learn more about this condition. The first group includes the separated placenta lying in the vagina, uterus or peritoneal cavity. In the second group the morbidly adherent placenta has a normal anatomical attachment but there is a breakdown in the physiological process of separation. In the third group there is anatomical adherence of the placenta to the uterine wall, and it is in these cases that prompt hysterectomy is required.

I wish to thank Mr. Eardley Holland and Mr. Alan Brews for allowing me to present this case.

## TREATMENT OF PLACENTA ACCRETA

	Irving and Hertig	Lawson and Oginz	Mayer and Ashworth
Maternal mortality following			
Manual removal	64.5	72	58
Partial removal and vaginal hysterectomy	36.4	36	36.4
Partial removal and supra- vaginal hysterectomy	20	5.6	18.9
Supravaginal hysterectomy	0	—	0

**Crying in utero.**—DONALD BLAKE FRASER, F.R.C.S.

This case may be of interest in that it affords collateral evidence of foetal respiration *in utero* in admittedly unusual circumstances, and also because it is an exception to the generalization that foetal crying is a sign of distress.

The patient, multipara 5, was admitted in her 31st week as an emergency case of ante-partum hæmorrhage. Membranes had ruptured four days previously and there had been slight bleeding. On admission she was draining liquor without meconium or blood. The uterus was of size corresponding to dates, the presentation was vertex 1, not engaged and she was not in labour. The cervix was not dilated, admitted a finger and no placenta was felt.

On listening to the foetal heart, which was regular at 150, it was noted that the child was respiring audibly *in utero*. The sound was just the same as the whimpering cry in expiration of a new-born child. It was rhythmic and continuous, varying in intensity. Sometimes it could be heard without a stethoscope. The nurse who washed the patient on admission was quite startled by it.

The child could be made to cry louder by gentle external prodding. An air bubble was demonstrated in the uterus by percussion and a splash could be heard on rocking the patient. The child cried for forty minutes, stopped and did not cry again.

She did not go into labour for another thirty hours. She then had a short first stage of four hours and a violent second stage, the child being born precipitately. The baby was small, 3 lb. 3 oz., and feeble at birth. He cried normally but became progressively weaker and died in three hours.

Post-mortem showed hæmorrhage in frontal lobe, left side and lateral ventricles. The lungs were poorly expanded with patchy atelectasis. Precipitate delivery, on prematurity, had apparently caused cerebral hæmorrhage.

**Comment.**—The facts are that there was air in the uterus and that the child did cry for 40 minutes, at which time it was in no distress. The air probably did not enter the uterus spontaneously and I suggest that the foetus normally respiring liquor, having been presented with air as a medium audibly respired for a time and then returned to the less dramatic and more physiological type of foetal respiration.

**Crying in utero.**—BARBARA FIELD, M.B.

The patient, para 1, attended the ante-natal clinic at about the fourth month of her pregnancy. She was a small woman, 4 ft. 10 in. with small pelvic measurements. The history of her first confinement suggested mild disproportion. She had a well-compensated chronic rheumatic carditis. She remained very well, but in view of her history, it was decided to induce labour at the 38th week.

In due course she was admitted and on August 8 taken to the labour ward. The foetus was in the L.O.A. position with the head free. High rupture of the membranes with a Drew Smythe catheter was performed without anaesthesia. After about a pint of liquor had been withdrawn, the flow stopped, and air could be heard being sucked into the catheter which was still in position with the tip near the foetus' face. The blast of air evidently acted as a strong stimulus, for immediately afterwards, muffled cries could be heard coming from the foetus. These were loud enough to be heard by the attendants several feet from the bed, and by the patient herself; they continued three to five minutes after the catheter was removed. The mother was taken from the lithotomy position and moved up the bed. On palpating the head to see if it had fixed, the crying started again, but soon stopped. This was repeated once or twice, but the effect soon wore off.

Frequent readings of the foetal heart-rate were made. This varied from 150-90 for the first twelve hours, then settled at about 130.

Regular labour pains did not start until fifty-four hours after the rupture of membranes. The labour was uneventful, and at 2.15 a.m. on August 11th she had an easy spontaneous delivery of a female child weighing 5 lb. 12 oz. who cried at once. The separation and expression of the placenta were accompanied by a marked expulsion of air from the vagina. The puerperium was normal and the child did well.

References to this condition are made in the literature but few cases are described in detail. Those I read occurred some years ago, about 1901, before the respiratory movements of the foetus *in utero* were understood. It was evidently considered as a dire



emergency from which the foetus must be rescued with all speed. They mostly occurred during application of forceps for a floating head, with little or no anæsthetic.

The fatal cases were probably due to the heroic efforts at delivery rather than the crying. In one case where the efforts had been abandoned the child was born alive nine days later. Crying *in utero* is probably rare because the manœuvres likely to introduce air into the uterus are usually performed under anæsthetic and other conditions likely to depress the foetal reflexes.

**Thecoma of Ovary.**—JOSEPHINE BARNES, D.M., F.R.C.S., M.R.C.P.

The tumour commonly known as thecoma of the ovary was first described in 1927 by two Italians, Moretti and Arrigoni, who named it "fibroma thecocellulare xanthomatodes ovarii". A more detailed description with a report of six cases was given by Löffler and Priesel in 1932 and these authors added a further four cases in 1934. Since then a good many reports of cases have appeared, mainly in the American literature. One case has been reported in this country by Patterson and McCullagh (1933).

The tumour occurs mainly in women who have passed the menopause, though several of the reported cases have occurred in younger women. It may cause menstrual irregularity or post-menopausal bleeding. It is always unilateral and is a solid tumour, consisting of connective tissue cells, surrounding islets of more deeply staining cells, which in suitably stained sections will be seen to be laden with fat droplets. These cells may be epithelioid or spindle-shaped. Wolfe and Negus (1941) were able to demonstrate that these fats are mainly cholesterol and phospholipoids. Geist and Spielman (1935) showed that the tumour contained œstrogenic hormone, and, using castrated mice, were able to show that the amount exceeds that found in an equivalent weight of placental tissue.

Malignancy is rare and unilateral oophorectomy is often the only treatment required.

**Case report:** The patient was aged 48 and had had eleven children. She complained of menorrhagia and occasional intermenstrual bleeding. The last period began on 26.3.42.

27.3.42: Examination under anæsthesia. The uterus was bulky and a small swelling was felt in the left ovary. Curettings were profuse and the case was thought to be one of metropathia hæmorrhagica with an ovarian retention cyst. Radium (3,000 mg. hrs.) was inserted into the uterine cavity. Section of the curettings showed a hypertrophic endometrium in the secretory phase.

23.6.42: Patient readmitted complaining of continuous bleeding since the insertion of radium.

26.6.42: Laparotomy. The uterus appeared normal. There was a small solid tumour in the left ovary. Total hysterectomy, bilateral salpingo-oophorectomy and appendicectomy performed.

The convalescence was uneventful and the patient is now well.

**Specimen.**—Uterus slightly bulky with a small submucous fibroid.

There was a small solid tumour in the left ovary 1½ in. by 1 in., which resembled a fibroma but with the characteristic yellowish areas. The right ovary was normal.

Sections of the uterine wall showed degeneration and atrophy of the endometrium. The ovarian tumour was a typical thecoma and a section stained for fat showed the characteristic droplets in the epithelioid cells.

**Nature and origin of the tumour.**—Novak (1940) believes these tumours are granulosa-cell tumours which have undergone luteinization. Schiller (1940) places the thecoma in the groups of tumours which arise from the ovarian mesenchyme and classifies them as a subgroup of the fibromata of the ovary. It is not possible at present to decide which of these views is correct, but there seems to be some ground for regarding the thecoma as a separate pathological and clinical entity. Traut and Butterworth (1937) were able to produce thecomata and granulosa-cell tumours in immature mice by irradiation of the ovaries, thus suggesting that the origin of the two groups of tumour is similar.

The interest of the case reported above lies in the presence of a comparatively rare ovarian tumour and in the persistence of uterine bleeding in spite of the atrophy of the endometrium caused by radium. It is suggested that in all cases of fibroma of the ovary, especially if there has been any irregular uterine hæmorrhage, a section of the tumour should be stained for fat. It is probable that this tumour is much commoner than the reports would suggest.

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## Section of Proctology

President—E. T. C. MILLIGAN, O.B.E., M.D., F.R.C.S., F.R.A.C.S.

[December 9, 1942]

### The Surgical Anatomy and Disorders of the Perianal Space

#### PRESIDENT'S ADDRESS

By E. T. C. MILLIGAN

THE perianal space is situated at the termination of the anal canal. Morphologically it represents part of the proctodæum. Clinically it is the area where painful lesions of the lower bowel occur. To understand and treat these maladies an accurate knowledge of its anatomy and physiology is needed.

*Contents of the space.*—The space contains the subcutaneous part of the sphincter ani externus muscle, the external hæmorrhoidal venous plexus, and fat. It is enclosed by sensitive skin and prolongations of the longitudinal muscle of the bowel (fig. 1).

*The subcutaneous sphincter ani externus muscle.*—This is the sole encircling muscle of the terminal part of the anal canal (fig. 2). It is a separate and distinct portion of the tripartite external sphincter ani muscle. The other two parts encircle the upper part of the anal canal surrounding the longitudinal and circular muscles of the rectum. The subcutaneous external sphincter ani muscle is separated from its fellows and the rectal musculature above by the intermuscular septum, a termination of the longitudinal muscle.

On its inner surface it is covered by the skin of the anal canal, on its lower aspect by the skin of the anus. Intervening between the muscle and these skin coverings is the corrugator cutis ani muscle and the external hæmorrhoidal venous plexus. On the outer side it is in contact with the perianal fat. The muscle is palpable throughout its whole extent. When in spasm it stands out conspicuously (fig. 3).

It is supplied by the inferior hæmorrhoidal nerves which cross the posterior half of the perianal space on each side. They are mixed nerves and mainly motor, but they also convey the sensory impressions from the skin coverings of the space. The muscle is under both voluntary and involuntary control. Its main function is to prevent by contraction foreign bodies from entering the rectum. It is seen to go into painful contraction in lesions involving the coverings and contents of the space. The most striking example is fissure-in-ano.

In defæcation it should dilate. Apart from this it has no active or indispensable part in defæcation. In the human being it can be cut in any way without ill-effect upon defæcation or continence. Continence depends on the rest of the anal musculature.

*Clinical facts.*—The subcutaneous sphincter ani externus is the structural cause of fissure-in-ano. If there were no subcutaneous sphincter there would be no fissure. Fissure does not recur when the muscle has been cut, so this operation is followed by permanent cure. For the proper functioning of the muscle it should relax and dilate to allow the solid formed stool to pass through. It needs the daily dilatation of solid faeces to keep it dilatable. Should this mechanism fail through the habitual use of a daily aperient, especially of the saline type, then the accidental passage of a hard stool pushes the undilated muscle in front of it, stretches the delicate skin of the anal canal and causes a breach. Proctocain or other anæsthetic solutions paralyse and relax the muscle if injected into both sides of the perianal space and so around the inferior hæmorrhoidal nerves.

The circular fibres of the subcutaneous external sphincter ani are exposed where the fissure penetrates through the fibres of the corrugator cutis ani muscle (fig. 13c).

The main tracts of fistulæ following infection of the perianal fat enter the anal canal usually above (the low anal fistulæ) but sometimes below the muscle (the subcutaneous fistulæ) in the proportion of three low anal to one subcutaneous (fig. 14b).

It will be seen later on that the muscle can be cut with advantage in fissure, in perianal abscess and in both anal and ano-rectal fistulæ.

*The skin of the anal canal and skin of the anus.*—The inner and lower aspect of the perianal space is covered by two varieties of skin. The lower  $\frac{1}{2}$  in. of the anal canal is transitional skin. The skin of the anus is true skin with sebaceous, sweat glands and hairs. The two types of skin can be identified by their appearance (fig. 4). If the skin of the anal canal appears at the verge or margin of the anus it is evidence of early prolapse of the pile (fig. 12 III).

The outstanding clinical characteristic of this lining is its *sensitivity*. It is the sentinel that guards the rectum and it is most sensitive to painful stimuli. Its sensitivity is the reason why lesions of the perianal space and its contents provide most of the painful lesions in proctology. The mucous linings of the anal canal and rectum lying above are not sensitive to painful stimuli, and so lend themselves to painless, submucous sclerosing injections. Stimulation of the skin causes reflex contracture and closure of the external sphincter ani especially the subcutaneous part. Lesions of the skin such as fissure or hæmatoma of the external hæmorrhoidal venous plexus cause spasm of the underlying muscle which in turn increases the pain of the causal lesion. There is some evidence that the corrugator cutis ani contributes to the exquisite pain of perianal hæmatoma.

It may be useful to point out that the normal skin lining is not sensitive to digital examination by the lubricated finger or instrument, providing there is no lesion of the perianal space. The patient draws away or holds himself tightly because the inserted finger causes the defæcation reflex and the patient becomes embarrassed. He should be assured that defæcation cannot occur.

There are two methods of examining the skin of the anal canal to demonstrate its concealed lesions, viz. digital and instrumental. The lining can be seen as it is everted by digital traction on the skin of the anus, while the patient helps by straining down. Tubular, slotted or duck-billed specula will demonstrate the normal lining or the presence of a tiny hæmatoma, fissure, polyp or sinus. If the lesion is painful a perianal anæsthetic is necessary to prevent suffering.

Redundancy of the skin over a large distensible hæmorrhoidal venous plexus at the site of the three hæmorrhoids is often seen. In these cases there need be no hesitation in removing enough skin in the skin cut of hæmorrhoidectomy to get flat wounds to insure satisfactory healing by second intention.

Healing of the skin of the anus after operation is sure and satisfactory. Large areas of perianal skin can be removed, as in removal of skin tags and in the treatment of ano-rectal fistulæ (fig. 5). It is wise never to remove the full circle of skin. Indeed it is never necessary. Stricture would follow and, at the sensitive skin level it is difficult to treat.

Unlike stricture of the mucosa it is inelastic and painful to dilate. In removal of hæmorrhoids, intact skin bridges or bars of at least  $\frac{1}{4}$  in. wide should be left between the three skin cuts to insure healing (fig. 6).

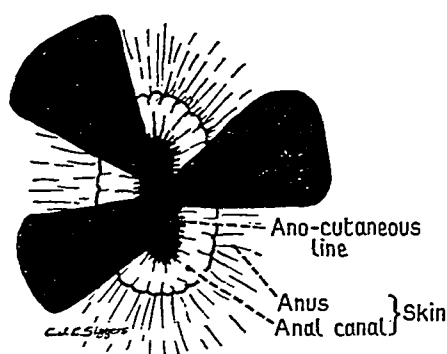


Fig. 6.—Black areas represent the trimmed skin cuts after removal of the three primary hæmorrhoids. Light areas—the intact skin bridges.

Of Nature's three methods of healing that of second intention can be accepted with confidence for the skin of the anus and anal canal. Neatly trimmed flat wounds will always heal. First intention is uncertain and succeeds in but a few cases so it should be abandoned for this area. Evidence of failure of the method of third intention is seen in the unhealed fistulæ which all call for treatment by the method of second intention.

Healing of wounds of the skin of the anal canal is slow compared to the healing of the skin of the anus. W. B. Gabriel has recognized this fact in planning his operation for fissure. A large area of the quickly healing skin of the anus is removed to prevent its healing before the smaller bare area of the skin of the anal canal heals (Gabriel, 1937). It is a curious fact that this transitional skin between mucosal lining and true skin should be so reluctant and hesitant to heal.

The skin of the anus is the site of pruritus ani in all its manifestations. It is here that the pleasure and relief by scratching turns into the pain of smarting and burning. The injection of novocain and proctocain into the perianal space causes anæsthesia of the skin and for a time stops itching sensations. The skin now untraumatized by scratching can return to normal, especially if bathed and treated. It is rarely that Ball's operation of cutting the nerve supply to the perianal skin by dissecting it from the underlying space is now done. Although 255 cases of pruritus ani attended St. Mark's Hospital from 1938 to 1941, only one case was operated on by this method. Patient persistence in the remedial measures described ultimately gives relief.

I have made no mention of the crypts of Morgagni which are lined by the skin of the anal canal. Maybe others can throw light on "cryptitis" which receives much attention in American practice and literature. In certain suspected cases of cryptitis, I have had the crypts examined but found no microscopical evidence of inflammation. The columns of Morgagni belong to the anal mucosa.

**Fissure-in-ano.**—This is a painful vertical abrasion of the skin of the anal canal or of the skin of the anus, so it might be named *fissure-at-anus* as well as *fissure-in-ano*. It is a stubborn fact of clinical experience that healing is uncertain. Indeed months may pass and healing be absent or unsound. The vertical slit varies greatly in length and depth. It may be but an eighth of an inch in length and situated in the anal canal just below the mucocutaneous junction. Here it is difficult to see on account of pain and spasm demanding a perianal anæsthetic injection for exposure. The fissure rarely extends upwards beyond the mucocutaneous junction which is the region of the attachment of the longitudinal muscle and so the submucous space is rarely opened. More commonly the ulcer extends downwards to the skin of the anus when it may be half an inch long and easily seen by gently separating the anal verge. It now has the tell-tale sentinel pile.

The depth of the ulcer varies. In some only the skin is broken and the radiating fibres of the sensitive corrugator cutis ani muscle are visible. In others the ulcer penetrates

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The circular fibres of the subcutaneous external sphincter ani are exposed where the fissure penetrates through the fibres of the corrugator cutis ani muscle (fig. 13c).

The main tracts of fistulæ following infection of the perianal fat enter the anal canal usually above (the low anal fistulæ) but sometimes below the muscle (the subcutaneous fistulæ) in the proportion of three low anal to one subcutaneous (fig. 14b).

It will be seen later on that the muscle can be cut with advantage in fissure, in perianal abscess and in both anal and ano-rectal fistulæ.

*The skin of the anal canal and skin of the anus.*—The inner and lower aspect of the perianal space is covered by two varieties of skin. The lower  $\frac{1}{2}$  in. of the anal canal is transitional skin. The skin of the anus is true skin with sebaceous, sweat glands and hairs. The two types of skin can be identified by their appearance (fig. 4). If the skin of the anal canal appears at the verge or margin of the anus it is evidence of early prolapse of the pile (fig. 12 III).

The outstanding clinical characteristic of this lining is its *sensitivity*. It is the sentinel that guards the rectum and it is most sensitive to painful stimuli. Its sensitivity is the reason why lesions of the perianal space and its contents provide most of the painful lesions in proctology. The mucous linings of the anal canal and rectum lying above are not sensitive to painful stimuli, and so lend themselves to painless, submucous sclerosing injections. Stimulation of the skin causes reflex contracture and closure of the external sphincter ani especially the subcutaneous part. Lesions of the skin such as fissure or hæmatoma of the external hæmorrhoidal venous plexus cause spasm of the underlying muscle which in turn increases the pain of the causal lesion. There is some evidence that the corrugator cutis ani contributes to the exquisite pain of perianal hæmatoma.

It may be useful to point out that the normal skin lining is not sensitive to digital examination by the lubricated finger or instrument, providing there is no lesion of the perianal space. The patient draws away or holds himself tightly because the inserted finger causes the defæcation reflex and the patient becomes embarrassed. He should be assured that defæcation cannot occur.

There are two methods of examining the skin of the anal canal to demonstrate its concealed lesions, viz. digital and instrumental. The lining can be seen as it is everted by digital traction on the skin of the anus, while the patient helps by straining down. Tubular, slotted or duck-billed specula will demonstrate the normal lining or the presence of a tiny hæmatoma, fissure, polyp or sinus. If the lesion is painful a perianal anæsthetic is necessary to prevent suffering.

Redundancy of the skin over a large distensible hæmorrhoidal venous plexus at the site of the three hæmorrhoids is often seen. In these cases there need be no hesitation in removing enough skin in the skin cut of hæmorrhoidectomy to get flat wounds to insure satisfactory healing by second intention.

Healing of the skin of the anus after operation is sure and satisfactory. Large areas of perianal skin can be removed, as in removal of skin tags and in the treatment of ano-rectal fistulæ (fig. 5). It is wise never to remove the full circle of skin. Indeed it is never necessary. Stricture would follow and, at the sensitive skin level it is difficult to treat.

(4) The fourth extension of the longitudinal muscle of the rectum is the *recto-urethralis muscle*. This so-called muscle is however not related to the perianal space. It is an attachment of the longitudinal muscle closely and firmly to the triangular ligament, to the urethra, and to the apex of the prostate. It lies in the mid-line between the lower borders of the puborectalis muscle and only becomes apparent as the dissected anterior surface of the rectum is retracted backwards.

*The external hæmorrhoidal venous plexus.*—Although often circular in outward appearance the external hæmorrhoidal venous plexus is arranged in segments or compartments and corresponds to the three primary piles of which it may be looked upon as a termination. Like other structures in this region it may be large in size or but poorly developed (fig. 10). Its outer border is well defined encircling the anus. Its upper or inner border is at the intermuscular septum inside the anal canal. Here at the mucocutaneous junction it joins the internal hæmorrhoidal venous plexus. The outer and inner borders indicate the landmarks and limits for the skin cut in the operation of hæmorrhoidectomy (fig. 11).

The plexus is collapsed and flat at rest but during straining as at every morning stool it becomes distended and stretches the overlying skin which then becomes redundant (fig. 12). Patients are sometimes alarmed at the size of a harmless distended plexus. By exerting a pull on the tethering intermuscular septum and corrugator cutis ani muscle the distended external hæmorrhoidal plexus becomes a causative factor in the prolapse of hæmorrhoids.

In large long-standing piles the external hæmorrhoids corresponding to the three primary piles appear at rest as separate tags or "bags" of skin which greatly distend when straining occurs. If thrombosis in these occur, then fibrous tissue replaces the circulating blood and permanent fibrous tags remain.

*Perianal hæmatoma*, the five-day painful self-curing lesion of the plexus, is situated as a rule deep to the corrugator cutis ani muscle, but the protruding globular isolated spontaneous variety are superficial, and for their excision the corrugator muscle is not cut. Intra-anal hæmatomata under the skin of the anal canal can be painful and uncomfortable as well as concealed in the tightly closed anal canal.

Patients are more terrified of a recurrence of a painful thrombosed external hæmorrhoid than the daily prolapse of internal piles. It is happily unusual for this complication to be repeated. In many cases it only occurs once in a lifetime. One would have expected that injection and thrombosis of the vessels in the corresponding internal hæmorrhoid would stop distension of the external hæmorrhoid with blood and so prevent thrombosis. I have not found this so in practice.

The external hæmorrhoid receives a variable vascular supply through the perianal space from vessels in the ischio-rectal fossa. The extent of this supply is seen in the number of arteries cut and requiring ligation in the skin cuts for removing piles. Whereas in many cases there are no bleeding arteries, in occasional cases as many as nine spurting arteries require ligation in each skin wound. The post-operative hæmorrhage which sometimes occurs in hæmorrhoidectomy after the patient returns to bed is usually from one of these arteries in the skin cut. It can be easily seen and ligated. It is unusual at this stage for bleeding to occur from within the anal canal because of a slipped pedicle ligation. Bleeding, if it does occur, is noticed on the operating table.

*Fat in the perianal space.*—The perianal space contains smaller and more compact particles of fat than that in the ischio-rectal space which is large and loose (fig. 7). The perianal fat is continuous outwards with the superficial fascia of the surrounding buttocks. The space is the most common site of infections in this region. Inflammation always ends in the easily recognizable perianal abscess.

The spread to the anal canal is usually at the intermuscular septum, and the probe in the abscess cavity will be felt for under the anal lining at this point even if it has not made an internal opening. When the probe is felt under the lining it is best to cut the subcutaneous external sphincter ani. Infection in this space also spreads by direct extension round the space but on rare occasions it extends outwards into the superficial fascia of the buttock (fig. 17). It never spreads deeply into the ischio-rectal space above. The most extensive outward spread presents a very simple surgical problem for no anatomical difficulties are encountered in the incisions to make a flat wound necessary for healing.

*Fistula-in-ano.*—In a previous paper (Milligan and Morgan, 1934) fistulæ were classified into two main types: those with the main tract extending above the ano-rectal ring.

the corrugator muscle, exposes the venous plexus or even the circular fibres of the subcutaneous sphincter ani externus (fig. 13). The perianal space has now been opened and subcutaneous abscess or fistula can occur. These anatomical and pathological facts may give us valuable data for prognosis and treatment. To relate them is a profitable field for further clinical research.

It is the practice to treat uncomplicated fissure first with perianal injections of procain. If this does not give relief or if there are subsequent recurrences, then operation, which gives permanent relief, should be undertaken. The patient willingly co-operates in measures which will prevent a recurrence of such dread pain. Recurrences are likely to occur if the inherited or acquired anatomical abnormality of the part is associated with perverted bowel function. Division of the subcutaneous external sphincter ani and enlargement of the skin wound is the radical cure. We may now fairly claim to know both the cause and cure of fissure.

*The longitudinal muscle.*—Whereas the circular muscle of the rectum ends simply and abruptly at the lower third of the anal canal in a well-defined margin, the longitudinal muscle ends in a more complicated way. It attaches the rectum to surrounding structures and ends in four fibromuscular expansions, viz.: The septum of the ischiorectal fossa; the intermuscular septum; the corrugator cutis ani muscle; the recto-urethralis muscle (fig. 7). The first three surround the perianal space except at its outer aspect. They influence diseases in this area.

(1) *The septum of the ischiorectal fossa* extends outwards from the lower part of the longitudinal muscle across each ischiorectal fossa dividing it into an *ischiorectal space* above and the *perianal space* below.

The thickness, strength and extent of this fibromuscular fascia vary in different subjects. Its presence is easier to demonstrate than its extent and connexions. It contains varying amounts of muscle fibre, seen in microscopical sections cut by Dr. Cuthbert Dukes. This septum must be stabbed with the knife if the finger is to be inserted easily to the top of the ischiorectal fossa to expose the levator ani muscle or the puborectalis muscle. This is a step in the operation to expose the prostate from the perineum. The septum prevents infection which starts in the perianal space from spreading upwards. It also confines for a time the deep and difficult ischiorectal abscess. Surface signs of inflammation only become apparent when the septum is penetrated and the perianal space involved.

(2) *Intermuscular septum.*—This extends transversely inwards from the lower end of the longitudinal muscle between the lower border of the circular muscle of the bowel, or as it is here called the internal sphincter ani which lies above, and the subcutaneous external sphincter ani muscle which lies below. It is attached to the mucocutaneous junction of the lining of the anal canal. It divides the internal from the external hæmorrhoidal plexus. With the septum of the ischiorectal fossa, the intermuscular septum forms the upper boundary of the perianal space and, when intact, prevents the spread of infection from the perianal space into the submucous space above. The septum is the main tethering force which holds the hæmorrhoid in its place (Milligan *et al.*, 1937). Failure to perform this function is seen in third degree hæmorrhoids (figs. 8, 8a, and 8b). The groove between the internal and external hæmorrhoid is then lost. A stretched, absent or inefficient septum becomes the indication for operative removal of the prolapsed hæmorrhoid for no amount of submucous reattachment of the pedicle of the internal pile by submucous injections can replace the work of this fibromuscular septum.

(3) *Corrugator cutis ani muscle.*—This muscle is attached to and closely underlies the skin of the anal canal and skin of the anus. It is a prolongation downwards and outwards of the intermuscular septum in a radiating sheet. With the skin it covers the lower aspect of the perianal space. The muscle itself is very thin but can always be identified by its attachment to the skin, for traction on its exposed or cut surface pulls on the skin. Identification and complete division of the corrugator muscle indicate that the proper depth has been reached in the skin cut in hæmorrhoidectomy and that a clean dissection of the external hæmorrhoidal venous plexus off the exposed subcutaneous external sphincter can then proceed (fig. 9). It is a sensitive muscle and in perianal injections of anaesthetics the patient should be warned when the needle traverses the muscle. It should be infiltrated with anaesthetic solution when there is to be a skin cut under local anaesthetic. With the skin it prevents in most cases the natural release of the painful blood clot in perianal hæmatoma. Infections under this muscle cause fistulæ whereas abscesses under the skin alone usually discharge and heal.

The muscle is exposed in fissure and its radiating fibres seen or it may be penetrated by the fissure (fig. 13).

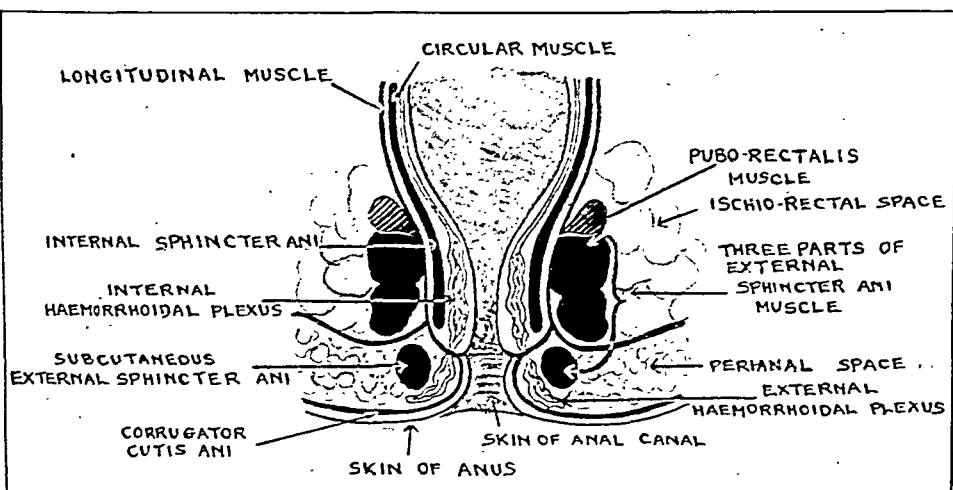


FIG. 1.—Diagrammatic coronal section of anal canal to show relations of perianal space.

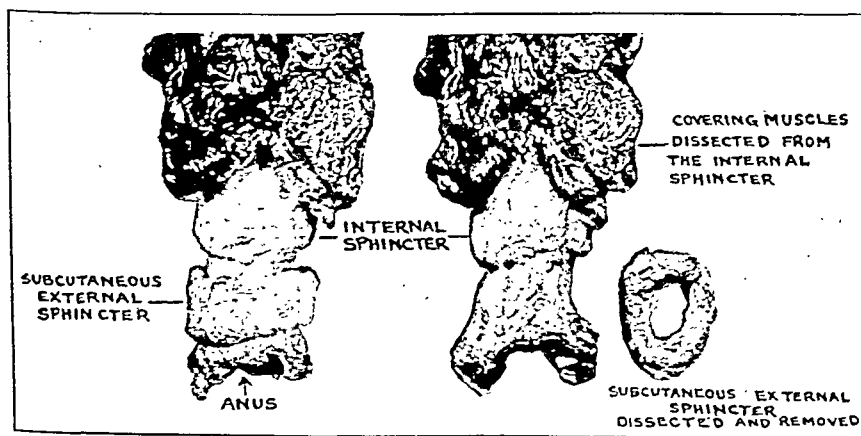


FIG. 2.—Photographs of dissected rectum showing internal sphincter and subcutaneous external sphincter ani muscle.



the *ano-rectal fistulæ*, and those with the main tract below the ano-rectal ring, the *anal fistulæ*. Of these latter there were *high anal* and *low anal fistulæ* depending on the relation of the main tract to the intermuscular septum.

The *fistulæ* which involve the *perianal space* are the low anal and the subcutaneous; fortunately for simple diagnosis, for easy surgical treatment, and for rapid healing they are the most common, viz. 76.2% (fig. 14).

*Fistulæ* in the *perianal space* usually reach the anal canal above the subcutaneous external sphincter at the intermuscular septum. It is to this palpable landmark, viz. the intermuscular septum, that the point of the probe following the main tract of the fistula in search of the internal opening can confidently be directed (fig. 15).

To produce a flat wound which will heal by second intention it is necessary to cut the subcutaneous external sphincter ani.

*Ano-rectal fistulæ*.—The long time required for healing of the deep wounds following the extensive operation on these fistulæ tries the patience of both surgeon and patient. It has been noticed that healing is hastened when together with the ano-rectal main tract there is an opening into the anal canal necessitating division of the anal muscles below the ano-rectal ring. The longest delay in healing appears to be when there is no opening into the anal canal and no pathological reason to cut anal muscles. We have found it aids the healing of the deep wounds left after the present surgical treatment of ano-rectal fistulæ if the subcutaneous sphincter is deliberately cut. The perianal space in that area is as it were abolished, and a more shallow wound produced (fig. 16).

*Injection of local anæsthetics into the perianal space* (fig. 18).—For pruritus ani, for fissure-in-ano, for hæmorrhoidectomy this has become a valuable procedure. The injection acts as a nerve block as well as a local anæsthetic. If the solution fills the perianal space it bathes the inferior hæmorrhoidal nerves which cross the space from the outer wall. The injection needle can traverse the space on each side of the anus through a single anæsthetized skin puncture about  $\frac{1}{2}$  in. behind the anus. The needle pierces the corrugator cutis ani muscle on each side as it enters the space. The patient only feels the prick in the skin and the two pricks through the corrugator. He should be warned that he will feel no further pain. If a watery solution of procaine precedes the anæsthetic in oil the total pain is small. If the solution is injected superficial to the corrugator muscle, swelling under the skin occurs. It is unwise to inject the oily solution in this plane; necrosis of the skin has occurred as a result.

Though infection after injection is a rare event, yet if the solution is confined to the perianal space and not injected into the ischio-rectal space, infection, if it should occur, could be easily dealt with surgically.

(Figs. 6, 7, 8, 8b, 9 and 11 are reproduced by permission of the *Lancet*.)

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—, —, JONES, L. E., and OFFICER, R. (1937) *Lancet* (ii), 1119.

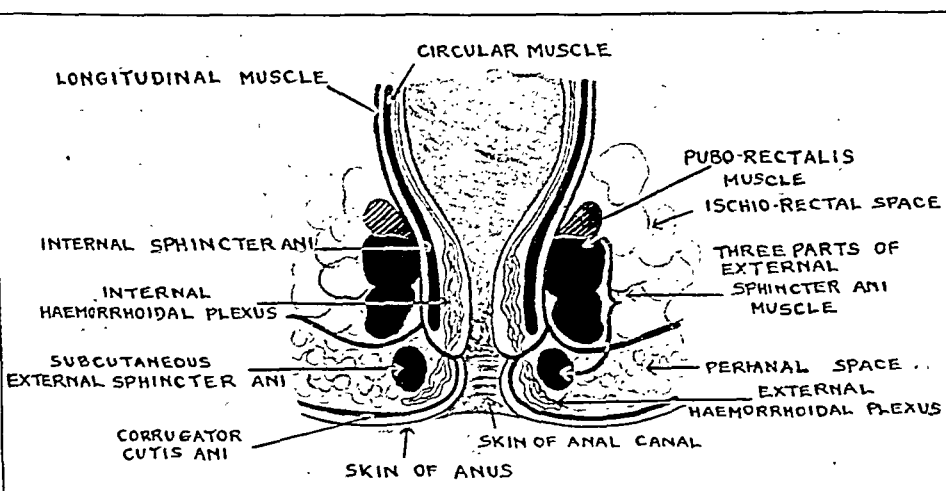


FIG. 1.—Diagrammatic coronal section of anal canal to show relations of perianal space.

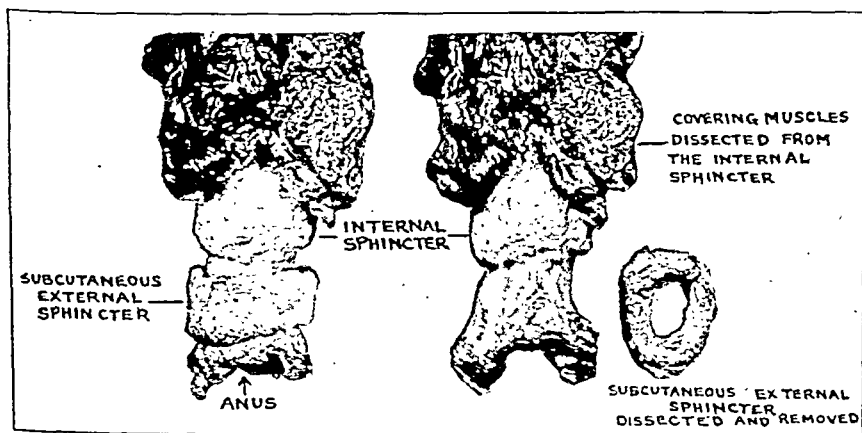


FIG. 2.—Photographs of dissected rectum showing internal sphincter and subcutaneous external sphincter ani muscle.

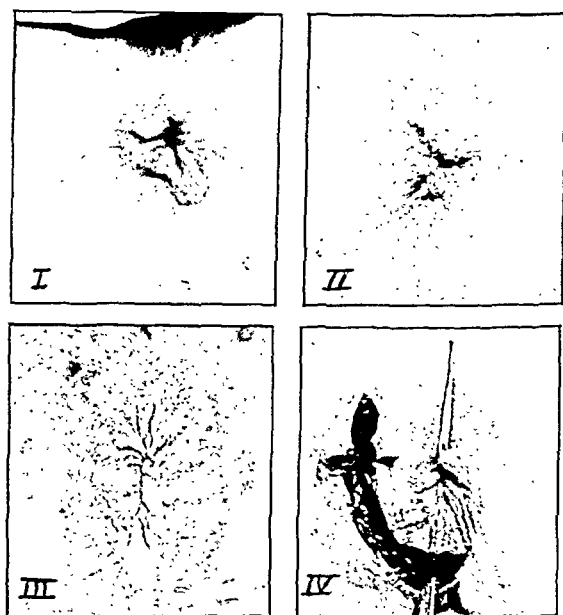


FIG. 3.—Contrast photographs to show the contracted and conspicuous subcutaneous external sphincter in fissure-in-ano. I. Fissure-in-ano. II. Untrimmed cuts in hæmorrhoidectomy. III. Pruritus ani. IV. Low anal fistula.

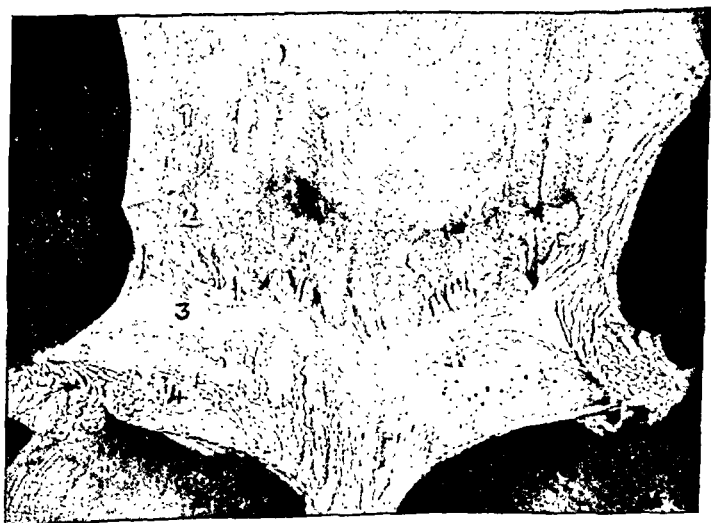


FIG. 4.—Anal canal and rectum opened from behind. The four linings are shown. 1. Rectal mucosa. 2. Anal mucosa. 3. Skin of anal canal. 4. Skin of anus.

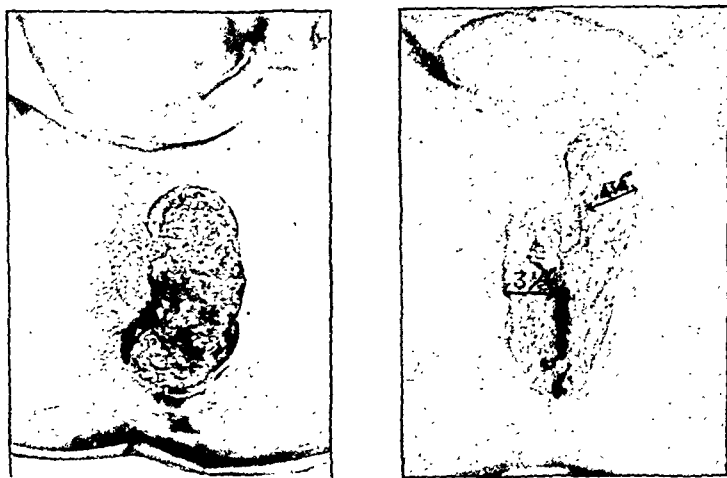


FIG. 5.—Anal and ano-rectal fistula wounds after operation, showing the large area of skin of anus and anal canal that can be safely removed. About one quarter of skin of anus is here left intact.

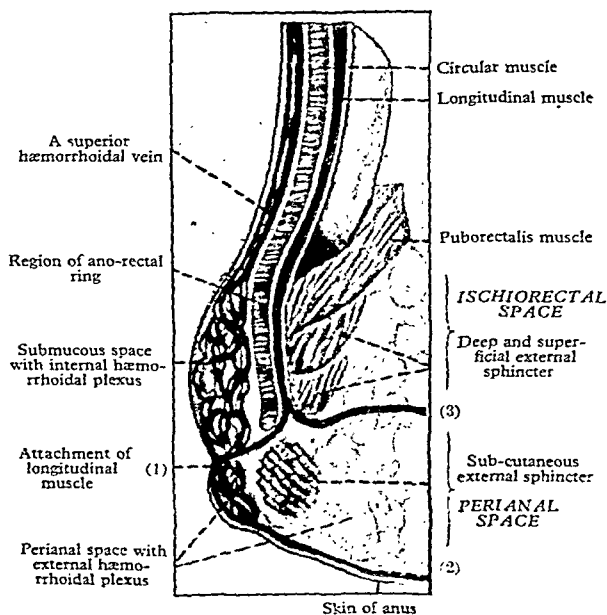


FIG. 7.—Showing the terminations of the longitudinal muscle (in red): (1) Intermuscular septum. (2) Corrugator cutis ani muscle. (3) Septum of the ischio-rectal fossa. Recto-urethralis not shown.

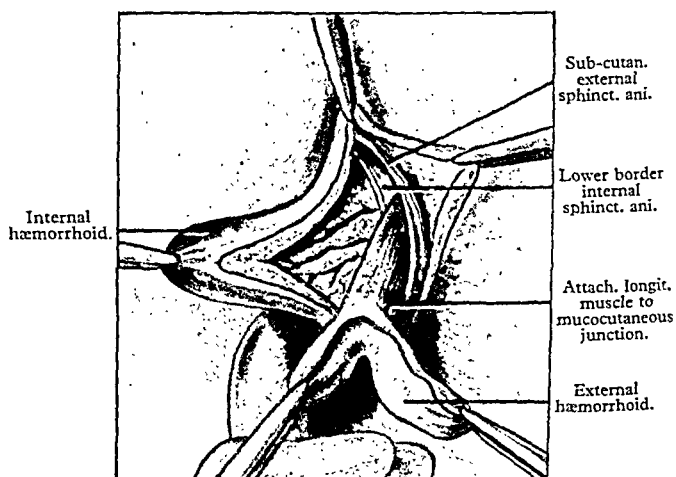


FIG. 8.—Dissection to show attachment of longitudinal muscle to the middle of the pile.

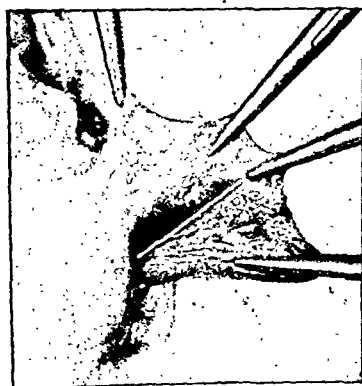


FIG. 8a.

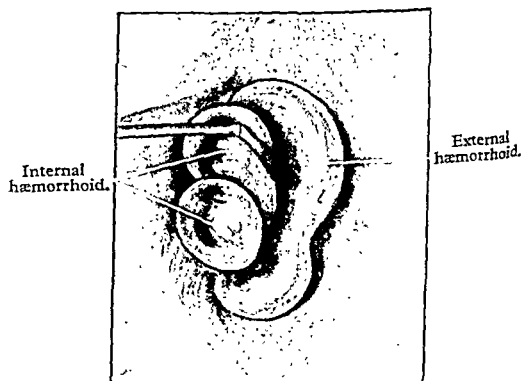


FIG. 8b.

FIG. 8a.—A prolapsed anterior pile, with stretched longitudinal muscle diagrammatically indicated, compared with a prolapsed thrombosed pile (fig. 8b).  
 FIG. 8b.—Prolapsed thrombosed intero-external left lateral hæmorrhoid. Note the presence of deep groove between external and internal hæmorrhoid where the longitudinal muscle is still effective.

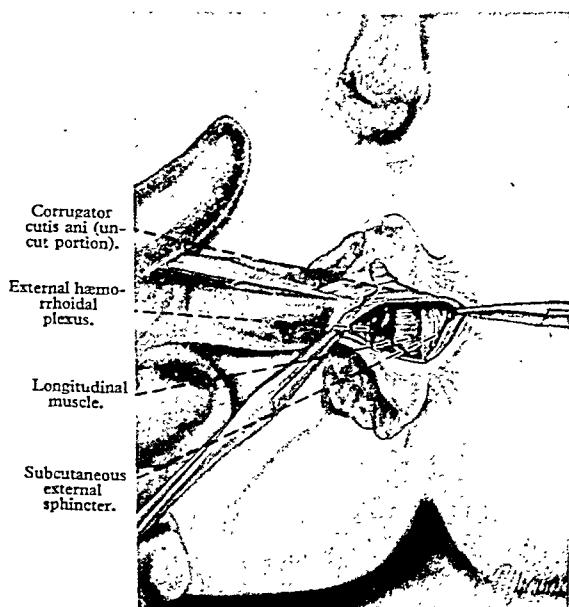


FIG. 9.—The cut corrugator muscle, showing the right depth for dissection of the external hæmorrhoid.

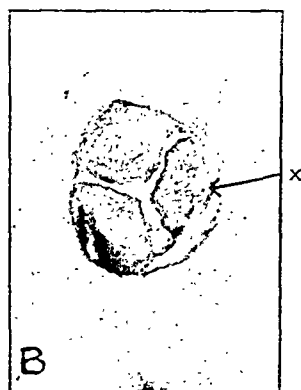


FIG. 10.—Photographs to show the variability of external hæmorrhoidal plexus. (A) Three distended external hæmorrhoids. (B) Three prolapsed internal hæmorrhoids. (X) Note undeveloped external hæmorrhoids.



FIG. 11.—Skin cut in hæmorrhoidectomy. From upper to outer border of external hæmorrhoidal plexus.

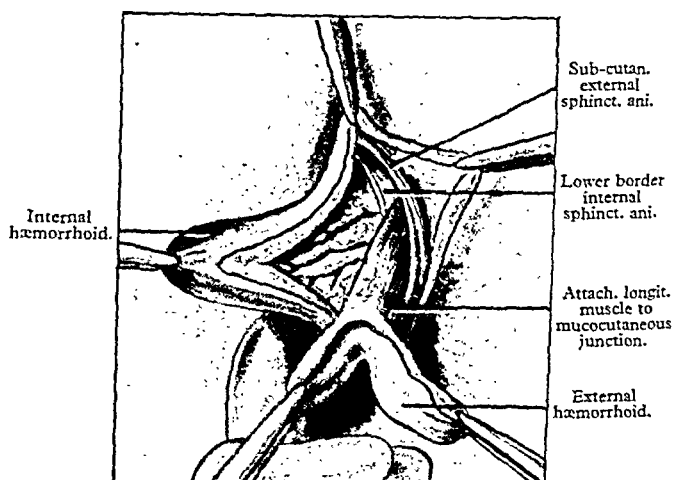


FIG. 8.—Dissection to show attachment of longitudinal muscle to the middle of the pile.

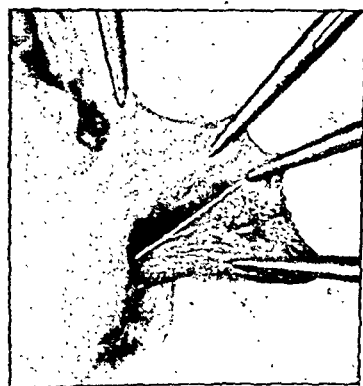


FIG. 8a.

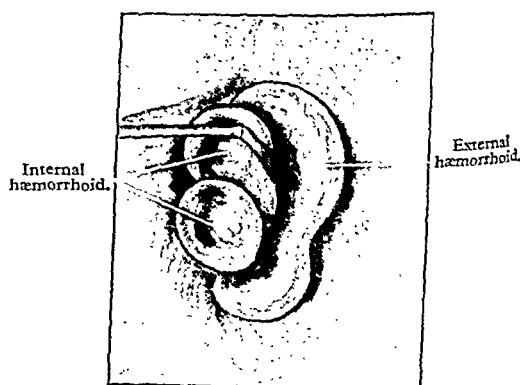


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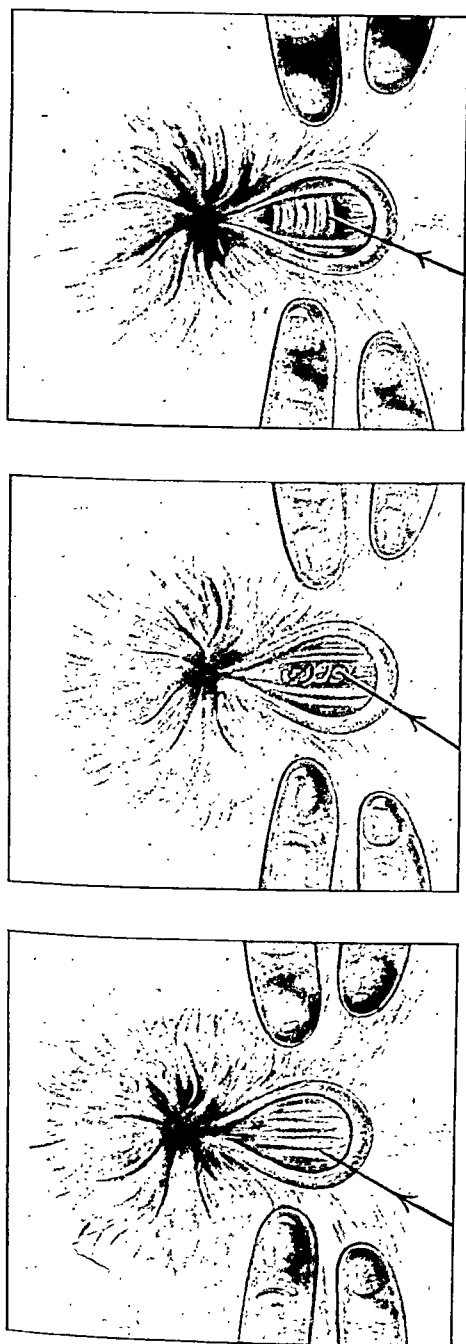


FIG. 13.—*a* Fissure-in-ano with corrugator muscle exposed.  
*b* Fissure-in-ano with external hemorrhoidal plexus exposed.  
*c* Fissure-in-ano with subcutaneous external sphincter exposed.

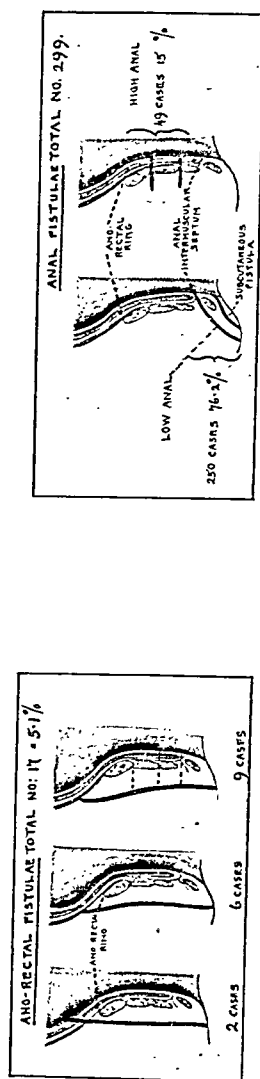


FIG. 11.—Cases of fistula-in-ano, 1930-1941, St. Mark's Hospital. (Total cases 328.)

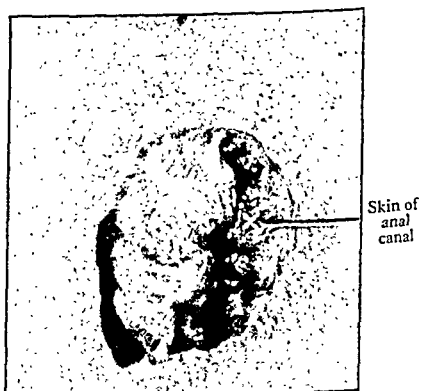




I



II



III

FIG. 12 (I, II, III).—Degrees of distension, eversion and prolapse of the external hæmorrhoidal plexus, on straining.



FIG. 15



FIG. 16

FIG. 15.—Method of finding the internal opening of a low anal fistula. The probe in the main track is directed to the palpating finger at the intermuscular septum and felt for under the lining of the canal, before searching for the internal opening.

FIG. 16.—The deep operation wound for ano-rectal fistula with uncut subcutaneous external sphincter. Suggested extension of wound outlined.

## Section for the Study of Disease in Children

President—DONALD PATERSON, M.D.

[February 26, 1943]

MEETING HELD AT THE HOSPITAL FOR SICK CHILDREN, GREAT ORMOND STREET,  
LONDON

**Collapsed Intervertebral Disc Following Lumbar Puncture.**—B. J. HUSSEY, M.R.C.S.,  
L.R.C.P. (for Dr. WILFRED SHELTON).

*History.*—Girl, aged 4 years, was admitted to her local municipal hospital in May 1942, as a case of meningitis, with a history of sudden onset of vomiting and delirium. Lumbar puncture was performed, and the cerebrospinal fluid was found to be normal. No definite diagnosis was made, but she was discharged home in six days, apparently quite fit.

Four days after returning home she complained of headache, pains in the legs, and, in the words of the mother, she "seemed vacant at times".

On 29.5.42, four days after the onset of these symptoms, she was taken to the Hospital for Sick Children, and was admitted to Tadworth Court Hospital for investigation.

On admission, her gait was awkward, and she appeared to have pain in her back when she walked. There was a superficial suppurating wound at the site of lumbar puncture in the space between L2 and L3, and there was definite tenderness in this area. No abnormal signs were found in the central nervous system, and the cerebrospinal fluid was normal. A Mantoux, 1:1,000, was negative, and the blood sedimentation rate was 3 mm. per hour. X-ray of the lumbar spine showed that the space between the 2nd and 3rd lumbar vertebrae was markedly diminished.

The pain in the lumbar spine was obviously increasing, and the child could not, under any circumstances, be made to flex the lumbar spine.

*Treatment* consisted of immobilization of the spine in a plaster jacket for three months, after which time gradually increasing movements were started, and later, graduated exercises.

X-ray at this time showed little change from the original.

Four weeks after coming out of the jacket she was able to flex her spine without pain, and two weeks later she could turn somersaults with ease. At this time she began to walk, and in a further two weeks was running about normally.

Since she was discharged from hospital four months ago she has been completely free from pain, and there is no stiffness. She does, however, appear to become quickly tired when she walks.

**Review of the Cases of Coeliac Disease in Hospital for Sick Children Since the Outbreak of War.**—ELEANOR K. PECK, M.D.

Coeliac disease appears to be on the increase since the War. There may be many contributory factors, such as the closing down of some hospitals, various shifts of the child population, the scarcity of general practitioners, or possibly an actual increase in the incidence of the disease under the present nutritional state of the country.

We have investigated the records of this hospital for the three and a third years' period from September 1939 to January 1943. A previous series of cases was reported for the fifteen years from 1923 to 1938 by Hardwick (Hardwick, C., 1939, *Arch. Dis. Child.*, 14, 279), and this serves for a comparison. [Two cases were shown at the Meeting, one from each series.]

The pre-war series consisted of 73 cases or .016% of the total new patients seen. Our series consists of 41 cases or .098% of the total new cases seen. That is, the case-incidence would appear to have increased sixfold.

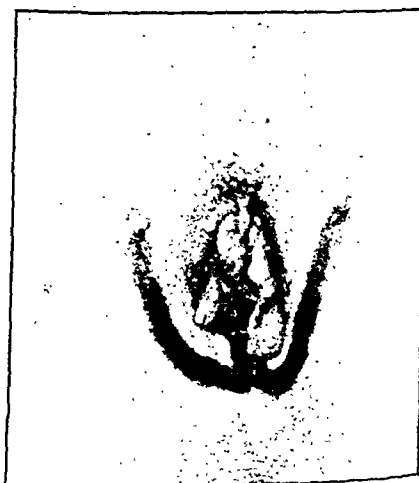
The average age of the onset of symptoms as far as could be obtained from parental statements was 18 months which coincides with the peak of 19 months for Hardwick's series. The age when first seen in our cases was on the average 2 years.

The great majority of all patients showed the well-marked clinical appearance of the disease, but a few of our more recent cases have been picked up before wasting has become marked. This is encouraging, for it would appear that early and efficient treatment might shorten the course of this prolonged illness, and save much in the cost of hospitalization and nursing care.

All cases have had one or more faecal fat determinations. No glucose tolerance tests have been done. X-rays have been limited to cases where the clinical evidence suggested positive findings. One case of rickets has been observed, whereas Hardwick had four.

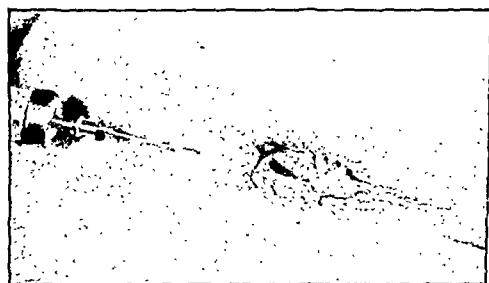


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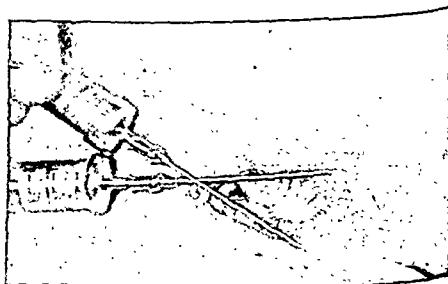


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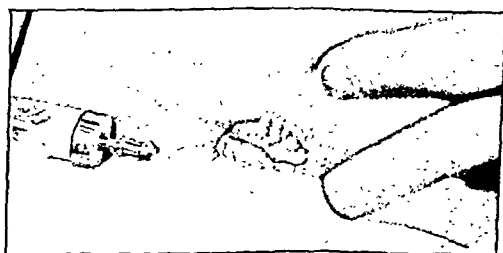
FIG. 17.—A—Multiple subcutaneous fistulae following outward spread of infection from the perianal space. B—Low anal fistula. Direct spread of infection around the perianal space.



1



2



3

FIG. 18.—Perianal injection. 1. Intradermal wheal. 2. Direction of needle on both sides of anus. 3. Showing depth and direction of needle. The point is palpated with the finger.

## Section for the Study of Disease in Children

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Four days after returning home she complained of headache, pains in the legs, and, in the words of the mother, she "seemed vacant at times".

On 29.5.42, four days after the onset of these symptoms, she was taken to the Hospital for Sick Children, and was admitted to Tadworth Court Hospital for investigation.

On admission, her gait was awkward, and she appeared to have pain in her back when she walked. There was a superficial suppurating wound at the site of lumbar puncture in the space between L2 and L3, and there was definite tenderness in this area. No abnormal signs were found in the central nervous system, and the cerebrospinal fluid was normal. A Mantoux, 1:1,000, was negative, and the blood sedimentation rate was 3 mm. per hour. X-ray of the lumbar spine showed that the space between the 2nd and 3rd lumbar vertebrae was markedly diminished.

The pain in the lumbar spine was obviously increasing, and the child could not, under any circumstances, be made to flex the lumbar spine.

*Treatment* consisted of immobilization of the spine in a plaster jacket for three months, after which time gradually increasing movements were started, and later, graduated exercises.

X-ray at this time showed little change from the original.

Four weeks after coming out of the jacket she was able to flex her spine without pain, and two weeks later she could turn somersaults with ease. At this time she began to walk, and in a further two weeks was running about normally.

Since she was discharged from hospital four months ago she has been completely free from pain, and there is no stiffness. She does, however, appear to become quickly tired when she walks.

**Review of the Cases of Coeliac Disease in Hospital for Sick Children Since the Outbreak of War.**—ELEANOR K. PECK, M.D.

Coeliac disease appears to be on the increase since the War. There may be many contributory factors, such as the closing down of some hospitals, various shifts of the child population, the scarcity of general practitioners, or possibly an actual increase in the incidence of the disease under the present nutritional state of the country.

We have investigated the records of this hospital for the three and a third years' period from September 1939 to January 1943. A previous series of cases was reported for the fifteen years from 1923 to 1938 by Hardwick (Hardwick, C., 1939, *Arch. Dis. Child.*, 14, 279), and this serves for a comparison. [Two cases were shown at the Meeting, one from each series.]

The pre-war series consisted of 73 cases or .016% of the total new patients seen. Our series consists of 41 cases or .098% of the total new cases seen. That is, the case-incidence would appear to have increased sixfold.

The average age of the onset of symptoms as far as could be obtained from parental statements was 18 months which coincides with the peak of 19 months for Hardwick's series. The age when first seen in our cases was on the average 2 years.

The great majority of all patients showed the well-marked clinical appearance of the disease, but a few of our more recent cases have been picked up before wasting has become marked. This is encouraging, for it would appear that early and efficient treatment might shorten the course of this prolonged illness, and save much in the cost of hospitalization and nursing care.

All cases have had one or more faecal fat determinations. No glucose tolerance tests have been done. X-rays have been limited to cases where the clinical evidence suggested positive findings. One case of rickets has been observed, whereas Hardwick had four.

MAY—DIS. IN CHILD. I

No scurvy has been seen. The previous observer found one case. In two patients marked osteoporosis was observed as against four in the preceding series. 29 cases were investigated for anaemia and of these 25 showed a Hb. below 80% on one or more occasions. These figures agree with Hardwick, who found 29 out of 33 patients to be anemic. In every case but one the anaemia was hypochromic.

The treatment employed did not vary greatly from that in the previous series except for the omission of such remedies as bile salts, pancreatic extracts, insulin and opium. A fat-free or low-fat diet was employed almost universally. Various available liver extracts formed the bulwark of treatment. The addition of supplementary vitamins, iron, and on occasion transfusion, played an important part, and probably contributed to the low incidence of clinical deficiency disease.

The corrected mortality of Hardwick's series was 30%, i.e. those dying of the disease. Five of our patients are known to have died. Of these, three developed bronchopneumonia in hospital. In one it was associated with an acute exacerbation of the disease, a second was admitted in an acute episode and developed the pneumonia, and a third, doing well, contracted measles and succumbed to bronchopneumonia complicating this. A death occurred in a child, who was in hospital under treatment for only two days, following a transfusion. The fifth case died of the disease itself. Including all these, the mortality is 12%.

These findings suggest that more cases of coeliac disease are being seen at this hospital since the War.

Observations made by May (May, C. D., McCreary, J. F., and Blackfan, K. D., 1942, *J. Pediat.*, 21, 289) recently, suggest that this is a deficiency disease due to one or more undetermined factors of the "B" complex. If this were so there may possibly be an increase in the disease under war nutrition.

**Pneumatocele, or Localized Bullous Emphysema Following Pneumonia.**—P. BARCLAY, M.B. S. C., female, aged 8 months.

**History.**—A healthy baby at 6 months of age developed an acute respiratory infection diagnosed as pneumonia and treated with sulphapyridine to which the condition responded. An X-ray of the chest taken on December 9, ten days after the onset of the illness, showed two small opacities at the right base. At this stage she developed a severe gastro-enteritis, for the treatment of which she was transferred to Great Ormond Street Hospital. When X-ray of the chest was repeated on December 19, two well-defined areas of diminished density had appeared at the site of the previous opacities. During the following six weeks, while the child remained extremely ill with the gastro-enteritis, a series of X-rays were obtained which showed the development of air-filled spaces in the right lung field. One of these increased in size until it reached the dimensions shown in figs. 1 and 2. It then became rapidly smaller and had disappeared by March 12, when X-ray of the lungs was normal.

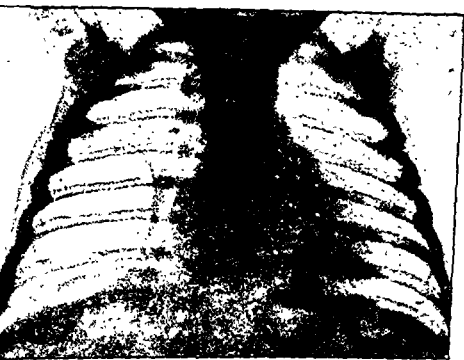


FIG. 1

Skiagrams of chest, antero-posterior and lateral, showing emphysematous bullae in right lung



FIG. 2

The baby had few symptoms referable to the chest condition. There was slight cough, but no dyspnoea, cyanosis, or clubbing. The signs in the chest were those of bronchitis, with scattered râles. At one time there was diminished expansion and air entry at the right base. Paracentesis was never performed, and the condition subsided without treatment.

*Comment.*—This case would appear to be one of pneumatocele or localized bullous emphysema developing after pneumonia. Similar cases have been reported by Benjamin and Childe (1939), Lister (1941), and others. The mode of development is probably that of a ball valve obstruction due to a plug of mucus or exudate in the lumen of a bronchiole. The expanding cyst may also lead to kinking of the bronchus which would add to the obstruction. Post-pneumonic necrosis with rupture of the bronchiolar wall was thought to be the cause in some cases (Pierce and Dirkse, 1937). The other possible diagnoses in this case are congenital cystic lung and localized pneumothorax.

The opacity seen in the first X-ray might have been a congenital cyst filled with fluid which subsequently ruptured into a bronchus. Against this is the fact that a fluid level was never seen, and that the cyst varied so rapidly in size, and finally disappeared. Some congenital abnormality of the bronchiole may, however, have been the underlying cause of the condition.

Adhesions giving rise to a localized pneumothorax of these dimensions is unlikely in such a young child with no previous history of lung disease. An artificial pneumothorax would finally have settled this point but was not undertaken owing to the child's poor condition.

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#### Metaphyseal Dyscrasia.—E. LUND, M.B.

V. C., a full-term female child; birth-weight  $5\frac{1}{2}$  lb.

Mother's first pregnancy; hydramnios; normal delivery. Deformities of arms and legs present at birth. Mother and father healthy. No family history of any deformity. Brought to hospital when she was 3 months old as she was not thriving. Weight was then 5 lb.  $13\frac{1}{2}$  oz. Bottle-fed.

The blood picture was normal.

Died suddenly during a feed at the age of  $4\frac{1}{2}$  months when she weighed 6 lb. 1 oz.

*Description.*—The head was large in proportion to the body. There were distended veins on the scalp. The hair was scanty. The anterior and posterior fontanelles were widely open. There were opacities in both lenses. The face was round and flat, with a marked depression of the bridge of the nose, and nasal discharge. The cry was very feeble.

*Arms:* The upper arms were extremely short, the elbows almost appearing to coincide with the shoulders. The elbows were permanently flexed to about 90 degrees, and could not be straightened. There was no movement at the wrists or in any of the hand or finger joints. The hands were deviated to the ulnar side. There was no deformity of the hands apart from their immobility.

*Legs:* The thighs were very short, and were bent to 90 degrees on the trunk. The knees were also bent to 90 degrees. The joints were again immobile. The knee and ankle jerks were grossly exaggerated. The plantar reflexes were flexor.

At post-mortem it was found that the muscles of the limbs were composed mainly of tough white fibrous tissue and were very short. Evidently this fact was the cause of the immobility of the joints. All organs except bones and muscles were normal.

*Pathologist's report on the femur* (Dr. D. M. Vaux): Length 8.7 cm. Upper cartilaginous epiphysis  $1.8 \times 2.6$  cm across.

The upper end of the shaft is broad.

The lower cartilaginous epiphysis is irregular and extends up along one side of the shaft. Many capillary blood-vessels are present in the epiphyses.

*Histology.*—Lower end. At the epiphyseal line a disorderly arrangement of cartilage cells and no evidence of invasion by marrow capillaries are shown; the medullary spaces being limited by a thin layer of bone immediately beneath the epiphyseal cartilage. The lower third of the shaft is distorted by a cystic area, the cyst walls are composed of fibrous tissue lined by osteoclasts and contain finely granular, calcareous material.

[March 26, 1943]

## JOINT MEETING WITH THE MATERNITY AND CHILD WELFARE GROUP OF THE SOCIETY OF MEDICAL OFFICERS OF HEALTH

DISCUSSION ON THE DECLINE OF BREAST-FEEDING (*Abstract*)

Dr. V. Mary Crosse: Since the Middle Ages there has been a definite decline in breast-feeding, both as regards the proportion of children breast-fed, and the length of period of feeding.

In the early twentieth century, the increased safety of artificial feeding and more scientific methods led to better results with such feeding. This caused a further decline in breast-feeding which had already been gradually reduced by the introduction of artificial feeding in the nineteenth century.

The period of breast-feeding had also been reduced to six months.

If, however, one is only considering the recent years, i.e. since the beginning of the War, the answer is probably not the same. The following figures are available from Birmingham and were collected by Dr. Ethel Cassie.

(1) 1938: An inquiry into the method of feeding of 4,378 children born between January and June 1937 and who were alive in January 1938.

(2) 1941-2: An inquiry into the methods of feeding of 1,937 children born during first quarter 1941; 2,698 children born during first quarter 1942.

This was undertaken for the British Paediatric Association.

The findings are as follows:

	1938	1941	1942
(a) Children artificially fed by age of 1 month	13%	7.9%	7.2%
(b) Children breast-fed 3 months or more	51%	53%	52%

Finding (a): It is interesting to note that in 1938, out of nearly 17,000 cases only 2.6% were artificially fed at the age of 2 weeks, i.e. when discharged from hospital or left by the midwife, yet by the age of 1 month this figure for artificial feeding had risen to 13%—and in nearly all cases the infant had been weaned before the health visitor had called, or the child had been taken to a welfare centre, i.e. in the absence of skilled advice.

The improved findings of 1941 and 1942 at this early stage may be due to the effort to close the "gap" by means of early visits, special clinics for very young babies, and better co-operation between hospitals, midwives and health visitors.

Finding (b): The figures for breast-feeding in 1941 and 1942 show a slight improvement on those of 1938.

*Effect of work on breast-feeding.*—It seemed probable that owing to so many of the mothers doing war-work, breast-feeding would be decreased. This has not proved to be the case in Birmingham. In 1938 11% of artificially fed babies were weaned because the mother was going to work. In 1941 12.8% and in 1942 11.7% of artificially fed babies were weaned for this reason. This group consists largely of unmarried mothers—as the number of illegitimate births has risen in Birmingham during 1942, the number of married women weaning their infants for this reason has probably fallen.

			Illegitimate births		
			1938	1941	1942
1st quarter ...	...	...	180	169	239

The general opinion of the superintendent health visitors of Birmingham is that married women not used to working in factories before the war, are not working now while their child is under 1 year—and that women used to working in factories are not starting work any earlier than before the war, i.e. not before the child is 2 to 3 months old. This opinion is borne out by the figures which show that 70% of the women who go to work, go after the child is 3 months old; and by the fact that there are relatively few applications for admission to the wartime nurseries for babies under 3 months.

Other war conditions which might reduce breast-feeding are queueing for shopping, anxiety for husbands, and air-raids. On the other hand, certain war factories may tend to increase breast-feeding. Husbands, who are at home, working on munitions, &c., are earning better wages, and their wives can afford to stay at home and look after the children. Better wages can also mean a better diet, thus leading to better breast-feeding. The supply of milk to expectant and nursing mothers and the extra vitamins should also prove helpful.

However good artificial feeding may be, it can never give the immunity to disease that breast-feeding can give. As an example to prove this, I can quote some figures from the Birmingham Premature Baby Ward.

While the mortality' rate of the babies during their stay in the ward is identical, whether they are fed with breast-milk or are artificially fed, the results after discharge from the ward show great differences according to the feeding.

Of all babies discharged alive and well from the ward:

4% are dead at 1 year of those breast-fed (i.e. entirely breast-fed six months).

6% are dead at 1 year of those partly breast-fed (i.e. breast-fed three months only, or breast + complement).

10% are dead at 1 year of those artificially fed.

Dr. H. K. Waller: Evidence of a decline in breast feeding can only be deduced from statistics, and I know of none which can claim to show it. On the other hand figures are available from many sources to show the current proportion of failures. Thus Dr. G. Walker found at Bournemouth that 23% of babies attending infant welfare centres in 1941 were breast-fed for less than two weeks, and a further 30% for less than three months. In my own clinic in East London roughly 25% are bottle-fed by the age of 1 month. No one is anxious to accept responsibility for them. The clinics are presented with an established failure; the mother says she has lost her milk and in a high proportion the statement is strictly true. "All was well," say the obstetricians and ward nursing staffs, "when they left us." "All is amiss," say the health visitors and clinic physicians, "when we follow them up." Is it possible there are factors causing these failures whose effects are only revealed in the second and third weeks? I believe it is so, and shall attempt to define two such common hindrances to success.

When active milk secretion begins on the third or fourth day after delivery, the baby is often reluctant to feed, sleeps after spending a few minutes at the breast, mouths and fumbles at the nipple, and gets only small quantities of food. In a favourable case, such as I want first to describe, these difficulties pass quickly; so that by the sixth or seventh day matters are greatly improved. The baby's grasp is more secure, it applies itself to its task with greater energy, a good and sufficient intake is registered. The loss of weight is checked and begins to be replaced by a daily gain. In such cases also it is usual for the breasts to leak freely in the intervals of suckling, and if a careful watch is kept, it can be observed that the leakage is not continuous, as it is often said to be, but tends to occur periodically—perhaps every hour or so. Any overfulness of the breasts subsides quickly, and by about the tenth day the mother is aware they are softer after the child has fed; that suckling in fact results in a definite emptying which brings her relief. This is specially the case in the morning if, as is customary in hospitals, no feeds are permitted during the night and the breasts have become overloaded.

By the time she is due to go home about the twelfth day, her baby has probably regained its birth weight. It has begun to display hunger coinciding with the time fixed for its feeds, and to sleep between whiles; though most newborn infants, I fancy, find the long night interval an unnatural infliction.

If we see this woman a fortnight later at the welfare clinic, we may find the child has already gained a pound, or as much as a pound and a half, in the interval. We shall hear, if we ask the question tactfully, she feeds it once during the night, but that she has observed the same feed-times during the day as were instituted in the ward. Questioned about her yield, she will very likely state with confidence that it has increased considerably; and that, though the spontaneous leakage has ceased, or nearly so, she can now recognize, just before or just as the child begins to feed, a sensation in the breasts which she describes variously as a "drawing pain", an aching, a prickling, pins and needles, and sometimes as a hardening. She quite likely offers the opinion that the baby now "gets his milk too fast", and that "he chokes himself". We hear also that soon after the start of the feed he withdraws from the breast to get his breath, and that when this happens the milk is spurting a considerable distance from the duct openings. There has now developed, in fact, a reflex mechanism whereby milk is expelled from the breast when a certain degree of tension is produced by accumulated secretion. It may later respond to other stimuli, such as the mouthing of the nipple, or the drinking of water preparatory to nursing.

The existence of this reflex compels us to reconsider the child's contribution to withdrawal of milk, usually thought of in terms of suction. I believe suction to be the force which draws the nipple far back towards the pharynx and not the force which extracts milk from the depths of the gland. In this position the ampullæ are squeezed empty by the rhythmic action of the mandible after the first outrush has subsided.

The draught reflex and its conditioning constitutes one of the main factors in the success or failure of breast feeding. It is appropriate to recall the Russian physiological school on conditioned reflexes and to remember how external influences such as pain,



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Other war conditions which might reduce breast-feeding are queueing for shopping, anxiety for husbands, and air-raids. On the other hand, certain war factories may tend to increase breast-feeding. Husbands, who are at home, working on munitions, &c., are earning better wages, and their wives can afford to stay at home and look after the children. Better wages can also mean a better diet, thus leading to better breast-feeding. The supply of milk to expectant and nursing mothers and the extra vitamins should also prove helpful.

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## Section of Medicine

President—GEOFFREY MARSHALL, O.B.E., M.D.

[March 23, 1943]

### DISCUSSION ON ATYPICAL PNEUMONIA

**Captain John W. Brown, U.S.A.M.C. :** Primary pneumonia may be divided into several groups: (1) Typical or lobar pneumonia, usually due to pneumococci and exhibiting a characteristic sharp clinical course. (2) Bronchopneumonia, also caused by bacterial agents and exhibiting a patchy distribution of lung lesions and a more insidious onset and irregular course than the typical lobar form. (3) Pneumonia for which no bacterial aetiology can be found. Influenza, psittacosis and Q fever are examples. A large number of cases have been observed for which no aetiology is known, and it is this group of conditions which is the subject of the present discussion. Many names have been used including acute pneumonitis, disseminated focal pneumonia, acute diffuse bronchiolitis, benign bronchopulmonary inflammation, acute interstitial pneumonia, virus pneumonia, and others. For uniformity it has been agreed to designate such cases as primary atypical pneumonia, aetiology unknown.

Interest in atypical pneumonia began in 1935. It was observed to differ from ordinary pneumonia by its mild character, paucity of physical signs, relative leucopenia, absence of bloody sputum, and hazy spotty appearance on X-ray. Later it was shown that sulphonamide chemotherapy did not influence the course. Many investigators have studied the condition and described groups of cases appearing in every section of the United States, in Hawaii, and in England. These include Gallagher, who reported from his experience in New England boys' schools, Bowen in Hawaii, Allen in Fort Sam Houston, Texas, Reimann in Philadelphia, Kneeland and Smetana from New York, Scadding in England, and Longcope from Baltimore. There are many other important contributions. Most of the cases have occurred in young people, especially in schools and army camps. Deaths have been rare and the disease on the whole mild. The incidence of recognized cases has increased yearly. It is an important cause of illness in troops. The question has arisen as to whether it is a new disease or simply being recognized in significant numbers for the first time. Reimann and others discuss the relation between atypical pneumonia and pandemic influenza of the 1918 to 1920 variety, since the aetiology of the latter has never been established.

The epidemiology of atypical pneumonia has not yet been settled. Transmission by droplet is likely and has the support of the observations of Kneeland and Smetana, Longcope, and Eaton. Some outbreaks in army camps seem clearly to be airborne in character. The disease is not highly contagious in its present form.

Few studies have been made of the pathology of atypical pneumonia. The papers of Kneeland and Smetana and of Longcope contain descriptions of autopsies of one case each. Essentially the process was a patchy, hæmorrhagic, interstitial bronchopneumonia with areas of atelectasis and emphysema. Microscopically there was a mononuclear exudate in the alveoli and walls with some polymorphonuclear leucocytes, some organiza-

fear and distracted attention act as inhibitors and how punctual repetition of stimuli and familiar environment assist the physiological processes. Mindful of this, is it not possible we underestimate the effect on some of the strangeness of entering hospital, the need for the patient to accommodate herself to its routine, to the alteration of diet, and to the personalities of the nurses and their professional ministrations? Then again, should we not remember that barely has she become familiar with all these when the process is reversed and she changes back to her home with the resumption of its duties and, for the first time, the full responsibility of tending her baby? The discovery that her baby screams a short while after she has fed it and exhibits violent contortions of pain may mean little to a woman of placid disposition, or to one who has had the experience before and has learnt to deal with it. To one of the opposite type these may assume a terrifying significance and play a great part in inhibiting the secretion.

Another cause of failure can be adduced from the mother whose yield is extinguished within a few days of the start of active secretion and whose baby is already bottle-fed before she makes her first attendance at the infant welfare centre. She asserts that she lost her milk soon after she got home and that this was clear to her because the baby was always crying, never satisfied and was hungry within an hour of taking the breast. A source of great anxiety to her was the infrequent green stools. The breasts had shrunk and often the child would not even attempt to feed when she tried to suckle it. She experimented with the bottle and found the feeds were eagerly taken and were followed by sleep. In these cases the history is significant. Lactation began in the same way as in the successful mother, but by the fifth day the breasts were tense, lumpy, painful and unyielding. The baby's efforts resulted in no more than half an ounce of milk being withdrawn. The sequelæ of increased tension, breast pumping without relief and damaged nipples became a dreaded torture. This was usually relieved by the eighth day but the baby had lost weight and the nurse had been obliged to supplement the feeds. All degrees of overloading may occur, and I am anxious to emphasize that it may involve the failure of milk to escape with sufficient freedom to reduce the tension within safe limits. Safe—because if the retention and overload persist, production declines, almost certainly due to excessive pressure within the alveoli upon the secretory cells. Moreover, the whole breast, including the nipple, may become œdematous, a clinical fact which is insufficiently recognized, and the nipple rendered specially liable to damage as the force of the child's suction falls upon it. This is nearly inevitable, since by reason of the tautness of the skin covering the breast, the nipple cannot be drawn into a position of safety but rests in the forepart of the mouth where it is not only sucked but bitten. The next stage is the absorption of the milk—there is no other explanation of its disappearance—and the return to the resting stage. This is the identical process which takes place when a baby is stillborn and the breasts are not used and are bandaged to the chest wall. Were I asked to define criteria by which satisfactory management of the first fortnight can be judged, I should largely disregard statements of the percentage of infants still being put to their mother's breasts and ask for a conscientious reckoning of the frequency of "cracked" nipples, of mastitis, and of breast abscess. They will indicate the success with which overload is prevented or checked, and so the possibility of the "draught" reflex being enabled to come into operation.

At the British Hospital for Mothers and Babies we set ourselves this standard. We found that relief by manual expression was too time consuming, and that teaching each mother on admission and before delivery was too heavy a task for the nursing staff, and so we began tuition on how to remove colostrum during the last three months of pregnancy. This ensured that the manipulations were learnt and practised daily, and the results were soon apparent in that the incidence of overloading was strikingly diminished. I cannot tell you how prenatal removal of colostrum assists the initial outflow of milk, but after we began it I found it is well-recognized as a preventive of mastitis in dairy farming. Since using it we have had only one breast abscess in the last 4,500 consecutive deliveries and no case of notifiable pyrexia due to breast conditions.

Lieut.-Colonel Gordon E. Hein, U.S.A.M.C.: Approximately 100 cases of so-called atypical pneumonia have been treated in our hospital during the past eight months. They appear to be clinically similar but we do not know for certain whether all are the same disease or are all caused by the same aetiological agent.

They differ from cases of bacterial pneumonia resulting from recognized types of pneumococci, streptococci, Friedländer's bacilli, and there are striking differences between these patients and the ones we saw who had influenza during the first World War.

Nor do these patients resemble closely, classical psittacosis. On the Pacific Coast, because of a large population of infected birds, scattered cases of psittacosis in human beings occur. They are characterized by pneumonia, patchy and shifting in type, cough with little or no sputum, mental cloudiness or delirium out of all proportion to the height of the body temperature, pulse slow in relation to the fever, leucopenia, and either demonstrable virus or positive complement-fixation test, increasing in titre as the disease progresses. A history of exposure to parakeets sick or well is often, but not necessarily, present.

Some years ago we observed a group of patients with the same scattered small shifting areas of pulmonary consolidation or infiltration. The sputum was likewise scanty in amount, leucopenia was present but the virus of psittacosis could not be demonstrated. True the complement-fixation test was positive for psittacosis, but it was only weakly so and it never reached the titre found in those patients who in the past had been diagnosed as having psittacosis. The disease was serious and fatalities occurred.

Then followed cases designated at present "atypical pneumonia". Atypical pneumonia is on the average not a serious illness; in fact, in some patients the disease is manifested chiefly by suppressed breathing, crepitant râles and X-ray evidence of pneumonia. The temperature elevation is only slight, cough is moderate, there is no blood spitting. A slight headache may be present, with backache and pain in the legs, but at no time in the course of the illness is the patient very uncomfortable. The pulse does not seem to be unduly slow, nor is mental confusion or delirium prominent. The white blood cell count is normal or slightly elevated; the sputum is not bloody, but it is greater in amount than in patients with frank psittacosis. Herpes is only occasionally present. The disease does not respond to the administration of sulphonamide drugs.

Interspersed between milder cases more serious cases may be observed. Retro-ocular headache may be intense. Pneumonia becomes extensive and the respiratory rate becomes extremely rapid. Moist râles appear diffusely in the lungs. The patients become stuporous and lie with half-closed eyes, breathing rapidly and noisily, and death seems imminent, but recovery has been the rule.

Atypical pneumonia in the U.S. soldiers in England differs in no essential from the disease observed in the United States, though serological or other laboratory differences may appear after further study.

Here are histories of four cases in our hospital in England; two had pneumonia and encephalitis:

CASE I.—On October 3, 1942, J. A. M., aged 22, a private in the A.U.S., was admitted to the orthopaedic service of the hospital because of an old shoulder injury. Twenty-three days later he developed pneumonia (October 26, 1942). It was marked by malaise, non-productive

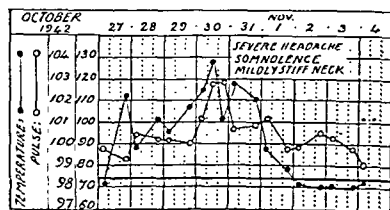


FIG. 1 (Case I).—Somnolence and photophobia appeared on October 31, 1942.

cough, and fever. Examination revealed crepitant râles in the lower lobes of both lungs but no frank consolidation. His pulse was 85 per minute, temperature 102. The W.B.C. on the third day of illness were 10,000, 75% of which were polymorphonuclear neutrophils. His temperature dropped to 100° F. then steadily rose for three days up to 104°. On the

tion and much hæmorrhage. There was infiltration with polymorphonuclear leucocytes and necrosis of the bronchial walls and also of the pulmonary artery and its radicals. The lesions are similar to those of psittacosis.

Since 1935 extensive studies have been carried out in the attempt to discover the ætiology of this group of conditions. Influenza may cause an atypical pneumonia without secondary bacterial invasion (Stuart-Harris): it has not, however, been found responsible for any significant outbreak of atypical pneumonia. The rickettsia of Q fever, *R. burnetii* (*diaporica*), was responsible for 15 cases of characteristic atypical pneumonia among laboratory personnel at the National Institute of Health in 1940. It has not been found causative in other outbreaks. The virus of psittacosis is now receiving much attention as an ætiologic agent of atypical pneumonia. The virus has been discovered widespread in pigeons and other birds in South Africa (Coles), Iceland (Bedson), Australia (Burnet), England (Andrewes), United States (Pinkerton and Swank, Eaton), and elsewhere. It was found in domestic poultry in Michigan by Eddie and Francis. In New Jersey, Meyer found the virus in barnyard fowls at the same time that human cases of psittacosis were appearing. A psittacosis-like virus has been isolated from cats (Baker). Rises in antibody to psittacosis in the blood during the course of atypical pneumonia has been found in a proportion of cases. Smadel found such a rise in 10 out of 45 cases, Reimann in 4 out of 8. Of our cases in San Francisco, Meyer found 3 out of 50 which showed a significant rise of antibody to the virus of psittacosis. An outbreak of atypical pneumonia occurred in San Francisco in which 3 out of 6 cases died. In this outbreak, Eaton, Beck, and Pearson isolated a virus like pigeon psittacosis and found rises of specific antibody in the blood of recovered cases. It is interesting to note that there is a close antigenic relation between the viruses of psittacosis, meningo-pneumonitis and lymphogranuloma venereum. An occasional case of atypical pneumonia has exhibited a positive Frei test. It is fair to conclude that some cases of atypical pneumonia are due to the psittacosis-ornithosis virus.

Many cases of primary atypical pneumonia fail to reveal evidence of the presence of a known ætiologic agent, even when exhaustively studied. Eaton has recently reported the isolation of a virus agent from such cases by using the eastern cotton rat. Weir and Horsfall reported isolation of virus from atypical pneumonia cases by using the mongoose. It would seem that the cause of most outbreaks of atypical pneumonia remains to be discovered. It is probably a group of conditions with different ætiologies. In order to establish the cause of any case it is necessary either to isolate the ætiologic agent during the acute phase of the disease or to demonstrate a rise of antibody in the blood against a known agent during the interval between acute and convalescent stages. We have stored serums from about 50 cases which will be tested in the future against agents yet to be discovered.

In the past few years we have observed occasional cases of psittacosis in San Francisco. These have been of the typical variety, severe, highly fatal and always having prior contact with psittacine birds. From 1938-1941 there were observed at the San Francisco and University of California Hospitals about 100 cases clinically characteristic of primary atypical pneumonia. Specimens from many of them were studied by Dr. Eaton and Dr. Meyer. An ætiologic agent was not discovered. Three cases had a rise in antibody to psittacosis during the course of the disease, determined by Dr. Meyer. During the epidemic of influenza A in 1940 no increase in the incidence of atypical pneumonia took place in San Francisco. During December 1941 to January 1942 there was observed an outbreak of atypical pneumonia in one small army unit. Fifty cases of acute respiratory infection occurred. They were clinically similar. Thirty had lesions in the lungs which could be demonstrated by X-ray. We believe that the same ætiologic agent caused all 50 cases. It was not discovered. Acute and convalescent blood specimens were obtained in all cases. No rise in antibody to influenza A or B occurred, determined by Dr. Eaton. These serums are stored for future study.

At a U.S. Army hospital in England there have been 143 cases of pneumonia from July 1942 to March 1943. 102 of these were atypical (about two-thirds). They presented the same characteristics as those observed in the United States. Most cases occurred during October and November 1942. There were no localized outbreaks.

Primary atypical pneumonia is of great importance at present because of its epidemic potentialities. Several infecting agents have been shown to be capable of causing this condition so that it cannot be considered a single disease entity. Nevertheless it seems evident that the ætiology of most cases of atypical pneumonia has not been discovered. Control measures must therefore remain inefficient.

clear. Subsequent series of films have failed to show any changes in this shadow. Films of the sinuses showed some thickening of the mucous membrane, but examination by the oto-laryngologist, including puncture and irrigation, failed to show evidence of active infection.

Since November 4, 1942, he has continued to complain of headache, tiredness, and moderate cough without sputum. He has had a low fever of 99.6° to 100° F., usually highest in the afternoon, for four and a half months. This is accompanied by a constant mild leucocytosis and an elevated sedimentation rate.

No cause has been found to account for the fever. Tuberculosis has been suspected. The lesion in the lung does not change, examination fails to reveal râles, tuberculin test is very weak at 1:1,000. Repeated sputum examination and culture fail to reveal tubercle bacilli. There is no history of syphilis, and the patient is serologically negative. There is no evidence that a malignant tumour is present.

Agglutination tests for the typhoid group and brucella group are negative. Frei test was negative. Spinal fluid failed to reveal evidence of meningo-encephalitis. So far no cause for the fever has been found. The fever apparently began with pneumonia and still is present four and a half months later.

CASE IV.—I. G. D., aged 21, was admitted December 9, 1942, from the dispensary, where he had been treated for bronchial pneumonia. He had been taken ill on December 4, 1942, with chilliness—pain in left lower chest, cough and fever. According to the record accompanying him, he did not cough up blood, nor did his temperature rise to over 100° F. He had no herpes, his throat was not red. Slight tenderness was present over the left lower thorax anteriorly and posteriorly, but no dullness, changes in breath sounds, nor râles were noted. A skiagram of the chest showed an area of peribronchial exudation still present in the left base. This persisted to December 23, 1942, but by January 7, 1943,

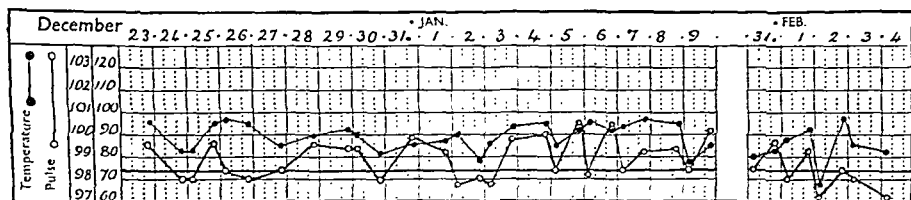


FIG. 2 (Case IV).—Illustrating character of prolonged fever.

the peribronchial exudate had disappeared. Blood-count on December 10, 1942: R.B.C. 4,550,000; W.B.C. 11,650 (polymorphonuclears 71%). December 29: 5,000,000 R.B.C., 7,500 W.B.C. (polymorphonuclears 56%).

Since the onset he has had an elevated temperature for which we have been unable to find a cause. Sinuses have been investigated. There is no evidence that he has tuberculosis or other pulmonary disease. Investigation of the genito-urinary system fails to show any evidence of infection. Kahn test is negative. There seems to be no lesion of the central nervous system. Frei test is negative.

Both these young men stated that they were well until the onset of their acute illness. In both the acute illness resembled clinically the syndrome which we call atypical pneumonia. Both have had a protracted low fever for which there is no apparent aetiology. Neither one is well enough to work at present.

Dr. Philip Ellman assumed that in this discussion of "atypical pneumonia" the reference was to the non-stereotyped pneumonias, as opposed to the well-recognized stereotyped form of lobar and lobular (broncho) pneumonia. He deprecated the use of the term "pneumonitis" which only served to confuse the issue.

Of the atypical pneumonias he supposed it would include the so-called "benign circumscribed pneumonias" and the benign broncho-pulmonary inflammations with transient X-ray shadows, described by Scadding. Those atypical pneumonias with so-called "delayed resolution" might also be included. A diagnosis of this nature was fraught with danger for it was essential in such cases to determine their exact aetiology. "Bronchogenic cancer" with surrounding pneumonia, where the pneumonia appeared to be predominant, was by no means uncommon; pulmonary atelectasis (post-operative), abscess and pulmonary tuberculosis with lobar consolidation must likewise be borne in mind.

With regard to pulmonary tuberculosis with lobar consolidation, Dr. Ellman divided these into (1) the so-called "acute benign primary pulmonary tuberculosis" (progressive primary complex) so admirably described by Louria and Ornstein; (2) adult pulmonary tuberculosis with lobar consolidation, attention to which was first directed by Rist.

fifth day of his illness (October 31, 1942) it was noted that he was somnolent and was unduly sensitive to light. His neck was stiff, and Kernig's sign was positive.

The W.B.C. rose to 14,000. The spinal fluid was hazy and had a ground glass appearance. The cell count was 380 per c.mm., 77% of which were polymorphonuclear cells and 23% were lymphocytes. Pandy's solution gave a fairly heavy cloud, sugar was high, 122 mg. in 100 c.c. and chlorides were decreased to 582 mg. in 100 c.c.

The gold chloride curve was not much changed, showing 1122100000. Culture failed to reveal any growth. His temperature began dropping on October 31, 1942, and two days later (November 2, 1942) it was normal. Fever never appeared thereafter. By the end of the week (November 2, 1942) all evidence of pulmonary inflammation had disappeared. In spite of normal chest findings and in spite of normal temperature, the spinal fluid remained hazy. The total cell count remained high (205 per c.mm.). All cells were lymphocytes. The sugar level dropped to 58 mg. and the chloride level rose to 786 mg.

The Kahn test with blood was positive, but the Wassermann test on blood obtained at the same time was negative.

Improvement in the neurological symptoms (somnolence, photophobia, stiff neck and Kernig's sign) were first noted on November 3, 1942, and all signs had disappeared by November 6, 1942 (eleven days after the onset). The spinal fluid changes persisted longer and on November 16, 1942, 14 lymphocytes were seen in the spinal fluid.

By December 1, 1942, the patient had entirely recovered. Signs of neurological involvement were absent and examination of spinal fluid showed no deviation from normal. The spinal fluid had lost its hazy appearance and was clear, the cell count had dropped from its high 380 to 6, Pandy test was negative. Sugar normal in amount. The patient was kept under observation until December 23, 1942, and was then returned to duty.

**CASE II.**—F. C. F., aged 34, also a private in the A.U.S., entered the hospital on October 28, 1942. Seven days before entry he had become sick with a mild illness characterized by coryza, sore throat, and a discrete maculo-papulo-pustular eruption over the trunk, which at first was suspected of being chicken pox but apparently was not. The day before admission, the sixth day of his illness, he developed a non-productive cough, chilliness, dizziness, and fever. On entry (October 28, 1942) he was acutely ill. He had a high fever (T. 105° F.) and evidence of pulmonary consolidation was present in the right lower and left lower lobes. Pulse-rate was 125 per minute. The day after onset of pulmonary symptoms, in spite of a drop in temperature, the patient complained of headache and became increasingly confused. Because of urinary difficulty he was catheterized on two occasions. On October 30, 1942, his neck was stiff. Otherwise, neurologically, he failed to present anything significant.

On November 2, 1942, the spinal fluid was clear, the cell count showed 26 lymphocytes. The Pandy test for globulin was positive. Sugar and chloride levels were essentially normal and the colloidal gold curve was flat, 00000000000. Cultures from the fluid failed to reveal any growth.

The white blood cell count was 13,000 on four occasions, although on the second day after admission it reached 16,000 per c.mm. with 78% polymorphonuclears (December 1, 1942), approximately one month after the onset of his illness, the patient was asymptomatic. The spinal fluid was clear. It contained 10 cells, all lymphocytes. Sugar was 59 mg. per 100 c.c. He was discharged on December 20, 1942, as well.

**Comment.**—We have had 100 cases of so-called atypical pneumonia. On the whole, the cases were mild. None have died. During the period in which these cases have been observed, there have been two patients with pneumonia complicated by meningo-encephalitis. Serological laboratory tests have not been available, so it cannot be stated whether these cases have a different aetiology or whether the encephalitis represents central nervous system involvement as a complication of the prevailing variety of atypical pneumonia.

I would also like to recount the histories of two patients with pneumonia and long-continued fever.

**CASE III.**—R. H. S., aged 27, a private in the A.U.S., was admitted to our hospital, November 4, 1942. His illness began about October 1 with chilliness and fever, headache, chest pain and cough with sputum faintly streaked with blood. Examination at the dispensary revealed pneumonia in the left lower lobe. He was treated with sulphathiazole and after six days the acute symptoms lessened, but headache, low fever, cough, and sputum persisted. The blood-count showed a moderate leucocytosis and an increased sedimentation rate. It is stated that the patient had a mild jaundice two weeks before he was transferred to our hospital, but he had none when he arrived and has had no evidence of icterus since.

Upon arrival at our hospital, he still complained of frontal headache, moderately productive cough, and tiredness, with occasional attacks of rapid heart action and palpitation. Admission temperature was 99.6°, pulse 88, resp. 18.

The physical examination, except for evidence of hypertrophic rhinitis, and slight lymphatic swelling in the posterior pharynx, was not noteworthy. The W.B.C. on entry were 15,500. 70% polymorphonuclears. Sedimentation rate was 39 mm. in forty-five minutes (Westergren method). Urine, sputum, and stool examination were repeatedly negative.

The chest film of November 5, 1942, showed a small area of infiltration in the right central lung field, in the upper part of the right lower lobe. Otherwise, the lungs were

## Section of Otology

President—F. C. ORMEROD, F.R.C.S.

[March 5, 1943]

### Audiogram Interpretation and the Fitting of Hearing Aids

By Major EDMUND PRINCE FOWLER, Jr., U.S.A.M.C.

Few, if any, otologists know enough about the fitting of hearing aids; many do not know enough about the tests for hearing which are so essential for a proper fitting. The otologist must learn enough to control the hearing aid industry just as the ophthalmologists now control the fitting of glasses. To do this he must thoroughly understand audiometry. "Snap" diagnoses are possible using a single tuning fork, but modern medicine calls for accurate quantitative tests. It is impossible to-day to follow, accurately, the progress of a patient or compare one test with another, without audiometry. Not to make an audiogram on a patient complaining of defective hearing or tinnitus is like omitting refraction on a patient complaining of defective vision. The more reputable hearing aid firms find that the audiogram permits them to rule out many of the possible combinations of amplifier, ear piece and battery power. If the physician cannot do all his own audiograms he should check the first one or two tests after they have been made. It is not wise for a physician to leave all his audiometry to a technician. They rarely have the training for critical analyses.

There are several technical details in the construction of audiometers and their use which are not understood even by otologists. Several workers have constructed audiometers and quite naturally they have selected their own zero levels. The basis for these levels is often obscure. Different kinds of graph paper for the recording of audiograms have been used (fig. 1). This made rapid comparison of audiograms difficult. The situation has now been remedied for commercial machines in the United States. The Committee on Hearing Aids and Audiometers of the American Medical Association and the American Bureau of Standards have agreed on a standard audiogram graph form and a standard zero level for commercial audiometers (Council of Physiotherapy, 1939). The new standard zero level (called average normal hearing) is so close to the original Western Electric level (Fowler and Wegel, 1922) that the difference is negligible. The Maico Company has also used a similar graph and zero level but they complicate it with per cent. lines (fig. 1 d).

It would greatly facilitate the reading of audiograms if the right and the left ear were recorded with the same symbols by everybody. For many years Fowler (1929) has designated ●—● for the right ear and O---O for the left ear, for air conduction, and [ for the right BC and ] for the left BC. It will be noted that a solid line is used between the dots for the right AC and a broken line is used between the circles for the left AC. No connecting lines are employed between the BC readings. The above symbols are used in this paper except for fig. 1. They permit facile reading and recording of the important limens even if all four readings for a single note are the same. An (X) is not used because one is so apt to write it carelessly (fig. 1 n). Use of red and blue makes journal reproduction difficult but is useful at times. When colours are employed, red should be used for the right ear, "Red—Right" makes for easy recollection of the symbols.

It will be noted that both air and bone conduction readings are recorded on the same graph (figs. 4 a, b, c, d). This is essential for quick and easy interpretation of audiograms, whether they are being used for the fitting of hearing aids or simply for routine otological work, such as diagnosis, prognosis, and the recording of change following treatment. Those who omit bone conduction readings from their audiograms,



Dr. Ellman's final inclusion in the category of atypical pneumonias was "Loeffler's syndrome" of fleeting pulmonary infiltrations with eosinophilia.

Cases—including both civilian and military sick—had come under Dr. Ellman's care, some of them being sent in as "Pyrexia of unknown origin". They occurred in the winter and spring months when respiratory diseases showed a peak rise. He described six such cases and showed serial skiagrams, illustrating varied forms of pulmonary infiltration with rapid resolution. Two of the cases closely simulated pulmonary tuberculosis and one suggested bronchiectasis but the subsequent bronchogram was completely negative. All cases showed a striking disparity between the scant physical signs and the comparatively extensive degree of X-ray lung parenchymal infiltration. They had a dry, non-productive cough, high fever, dropping by lysis, little disturbance of respiration and a comparatively slow pulse, so much so that on two occasions typhoid was suspected. Aching of the limbs was common, leucocytosis rare, the sedimentation rate markedly raised and showing little response to sulphonamides. Dr. Ellman supposed that these were similar to the cases described by Captain Brown and Lieut.-Colonel Hein and he felt that the more frequent use of portable X-rays for skiagrams of the chest in cases of vague respiratory illnesses during epidemic periods would probably disclose far more cases in this country.

Dr. H. Joules: At the Central Middlesex County Hospital all cases of pneumonia in adults are segregated in two wards and careful investigations are carried out. We deal with approximately 220 cases annually from a civilian population of 250,000.

An analysis of 57 cases, seen in the last three months, shows that 28 were true lobar pneumonias, from which a pneumococcus was obtained which could be typed. Seventeen had typical pneumonic consolidation, with a typical pneumonic onset, but no organism that could be typed. Twelve fell into the category of primary atypical pneumonia. In the first group an organism had been obtained, in certain cases, from the blood but not from the sputum; while in the second group blood and sputum examination had failed to reveal an organism. Lung puncture had been tried in a few cases, and it is felt that this method should be used in all patients before asserting that consolidation was non-pneumococcal in origin. Chemotherapy may sterilize the sputum but possibly not the lung. Many of the patients, of course, have had some chemotherapy prior to admission to hospital.

It seems possible, in the light of our present knowledge, that atypical pneumonia may give the same signs and have somewhat the same mode of onset, as pneumococcal pneumonia.

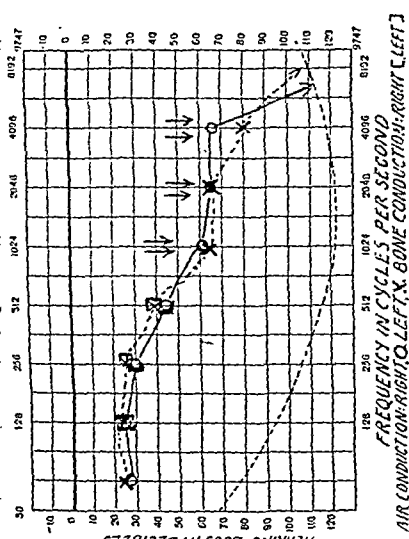


FIG. 1A.—Audiogram of the type used in Stockholm; reproduced from Sjöberg, *Acta Otolaryng.* (1910). Note difficulty in reading variation from the "norm" which requires subtracting the reading from each note from the normal line. This kind of audiogram gives a very good idea of the curve of amplification produced by an audiometer and is very similar to that used by German workers. (See 1C.)

FIG. 1B.—The same audiogram as in A, with the normal line straightened out as in American audiograms. The use of an (X) for the left ear is shown with simulated bone conduction readings. The use of a straight zero line for normal is a help, but the symbols are confusing. Compare 1D and fig. 4.

FIG. 1B.

AIR CONDUCTION—RIGHT, LEFT, X, BONE CONDUCTION—RIGHT, LEFT

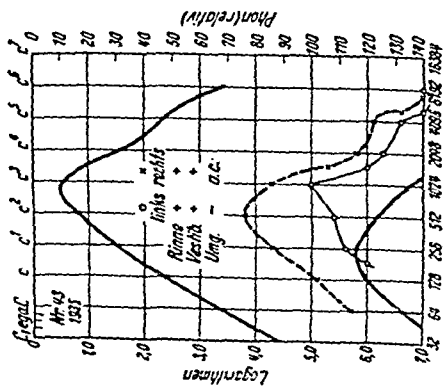


FIG. 1A.

FIG. 1C.—Typical audiogram chart used by German workers. The graph is of an extremely deafened patient. Note that the threshold of hearing and threshold of feeling are shown. (From Langenbeck, *Z. Hals-Nas- u. Ohrenheilk.*, 1933.)

FIG. 1D.—Audiogram shown in C transposed to a type of American audiogram chart with straight line zero level. The rather confusing percentage lines are now obsolete. The heavier lines at 250 and 2048 to indicate the speech range suggest that all the notes contained between them are of equal importance. This is not the case. Note (X) is here used for the right ear and that bone conduction readings omitted from the audiogram make it worthless from the standpoint of diagnosis. A standard method of recording should be adopted. (See fig. 4 for recommended symbols.)

FIG. 1C.

FIG. 1D.

Types of Audiogram Recordings. Compare German and Swedish types (1A and 1C) with a curved zero level, to American type (1B and 1D) where this curved line has been flattened out.

or record them on a separate chart, miss half the advantages of audiometry, i.e. the quantitative differentiation of nerve, conduction and mixed deafness. Many observers say that bone conduction tests are inaccurate and difficult to reproduce but they are still the standard for differential diagnosis and they help a great deal when it comes to the question of whether a bone conduction hearing aid or an air conduction hearing aid should be selected. To be sure, bone conduction tests are, as a rule, not as accurate as air conduction tests, but they are much more accurate than the usual tuning fork tests which they supplant (Fowler, 1929).

Whenever electric audiometers are used it must be remembered that there is no guarantee that they will remain correctly calibrated. On numerous occasions hearing aids have been recommended when not needed because of an audiogram taken on a machine which was not working properly or on a machine used in a noisy place. Soldiers, sailors and airmen have been improperly classified for the same reason. A simple routine to avoid these mistakes is for the operator to test himself before making a test on a patient. This procedure will not only tell the operator if the machine itself is in good order, but it will also give an idea of the testing conditions. If a masking noise over 20 db is present, it will be apparent in the audiogram of the operator providing his hearing is normal. 15 to 20 db is the amount of noise shut out by a tightly fitting receiver with a sponge rubber facing.

The use of a loud speaker has been found to have few advantages and several disadvantages, more particularly, the sound is too often heard in the better ear when testing a poorer ear. Mistakes occur from standing waves or may be due to either the poor fitting of the waxed cotton plug, used in the Stockholm method, or to reflections from the walls of the room or from objects in the room. Other patients, shown by Sjöberg (1940) in this same paper, which questioned the reliability of the audiometer, showed a typical loss obtained from vaselined wax cotton plugs. It is doubtful if any of these patients would have shown the same audiograms if tested again by the same method or with the more proper method of masking the less deafened ear as must have been done when the patients were tested with forks, for Sjöberg reports that in spite of good audiograms, forks were not heard at all, or that they were heard for very short intervals. A loud speaker attached to the audiometer is useful for testing binaural hearing or for the testing of hearing aids. Any room noise is particularly annoying when using a loud speaker audiometer instead of the tight-fitting receiver.

Few seem to realize that the factor of room noise is even more important in the voice and whisper tests for deafness than in tests with the audiometer because with voice and whisper tests masking noises affect not only the patient but also the examiner. In a series of experiments in a large sound-proofed room it has been shown by the author that 20 db of noise in the ears of the examiner makes it possible for the patient to hear the voice two or three times farther than when the only noise in the ears of the examiner was the 12 db ground noise in the room. This means a noise 20 db above threshold raised the voice of the examiner 5 to 10 db. 40 db in the ears of the examiner raised the voice so that it was heard three to nine times farther, i.e. 10 to 20 db. Greater noise in the ears of the examiner raised the voice, but not quite as much for each 20 db increase (Fowler, 1940).

20 db of ground noise on the ears of the examiner had little effect on whisper, but 40 db in the ears of the examiner made it possible for the patient to hear him two to three times as far. Voice and whisper tests in an ordinary office are not accurate enough for any quantitative purpose and are often extremely misleading. Comparison of hearing aids has to be made under more constant conditions. The most useful constant condition for hearing tests is absolute quiet such as that obtained in a sound-proofed room, whether the test is for diagnostic purposes, check following treatment, or for comparison of hearing aids. Through the courtesy of Air Commodore Dickson, more extensive experiments than those mentioned above are being conducted to measure the factor of ground noise on the voice of the examiner. Studies are also being made on the testing of hearing of military personnel as now performed. If it can be shown that more time and energy is lost by casual voice and whisper tests in the usual clinic environment than by audiometric tests by a technician, it should be possible to convince the military authorities that necessary instruments should be procured and enlisted men trained to do this work. One of the greatest drawbacks has been the construction of sound-proofed rooms, but even this may be important enough to be justified.

Since sound-proofed rooms are very expensive, it has been suggested that audiometric tests should be done with a constant masking noise as background. In practice this brings up new difficulties, particularly in diagnosis, for patients with nerve deafness hear loud sounds differently from patients with conduction deafness. They often, because

all-round purposes and especially for diagnosis and prognosis. If he can interpolate it for speech, the tests and special apparatus mentioned above are often not necessary. Steinberg and Gardner (1937) have constructed tables for the importance of various frequencies in speech. These figures would indicate that an audiogram should be weighted for the importance of various frequencies in English as follows:

250	500	1,000	2,000	4,000	8,000
2%	15%	20%	34%	26%	3% = 100%

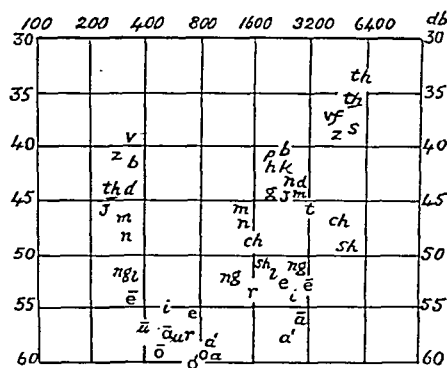
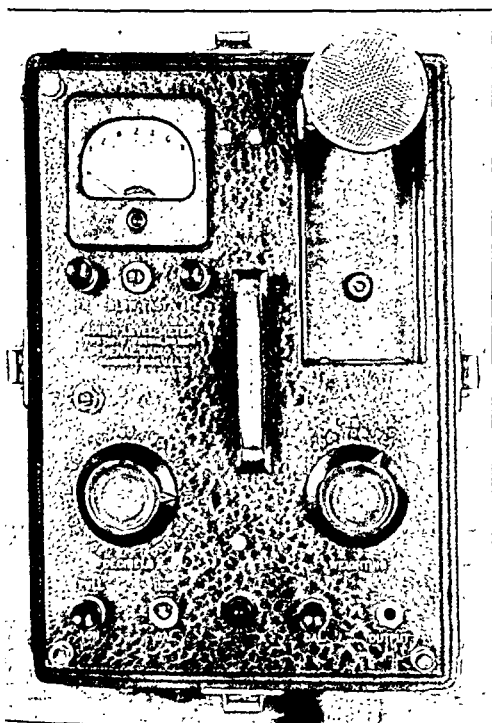


FIG. 3.—Rough diagram of the salient frequency characteristics of the various vowels and consonants as they would look on the usual audiogram chart between 30 and 40 decibels, the level of average speech. (Interpolation from Fletcher, "Speech and Hearing," London, 1929.)

FIG. 2.—Sound level meter manufactured by General Radio; also called a decibel meter. Note microphone in upper right-hand corner. Gross changes in 10 decibel stops are fixed with the dial on the left and the final readings of fluctuation in sound are read on the voltmeter. If the sound is too sharply peaked to read when the switch under the meter is on "Fast" the peaks can be ironed out and the summation of the power of the sound can be read off the "Slow" circuit. [Crown Copyright.]

The high weighting for 2,000 is important but clinical observatories indicate that the weighting for 4,000 is probably too high. After some years of study of patients with defective hearing, E. P. Fowler, Sr. (1942), has modified these weightings to

250	500	1,000	2,000	3,000	4,000	8,000
3%	15%	25%	30%	15%	10%	2% = 100%

To understand these weightings one should study the tables of Fletcher (1929) for the characteristics of the vowel and consonant sounds (fig. 3). The importance of the 1,000 to 3,000 pitch range becomes at once apparent. At least 70% of the intelligibility of speech appears to be dependent upon this region. For example, Patient (A), in fig. 4, has difficulty with hearing in spite of the fact that five octaves of his audiogram are close to normal. This patient obtained no improvement from a hearing aid because it was impossible to improve the hearing for his nerve deafness in the high notes to a better level than he could hear them without the aid. Patient (B), fig. 4, with a slightly greater loss and a much greater disability, had marked improvement in hearing if he wore a properly adjusted instrument, especially when sitting in conferences where he had been previously handicapped. The difference in these two patients is almost entirely in the 1,000 to 3,000 range. They were both men over 70 with deafness due to quinine. They both made the often heard statement: I can hear very well but I cannot always understand what people say." They heard the low-pitched

of recruitment,<sup>1</sup> hear loud sounds quite as loud as a normal person. If we try to ascertain the hearing level of such a patient, using a background noise, it would be impossible to know at what loudness to set the background noise so that it would not mask out the test material. The impedance of a conduction deafness is, on the other hand, the same for all intensities—such a patient will hear better in a noisy place and is notoriously easier to fit with a hearing aid. Ground noise will not bother him as much as a normal person.

There are a few other facts that are commonly not appreciated by inexperienced audiometrists. In using masking noise to cut out the untested ear, it is essential to know its loudness, for it must be remembered that any sound over 50 db in loudness shakes the whole head enough to be appreciated in both ears. Too loud masking in a poor ear will interfere with bone conduction tests of a good ear. For example, 75 db of masking noise applied to a totally deaf ear will reduce the hearing for both air and bone conduction of a normal ear on the opposite side of the head to 25 db. Too loud a hearing aid on a poor ear will produce masking of an opposite better ear.

For some reason it has been generally supposed that a high tone loss necessarily means a nerve deafness. This is not the case. For proof see Fowler's experiments with lead shot weighting the umbo (1928), or Loch's experiments with the Eustachian tube (1942) or experiments with cotton on the external meatus (Fowler, 1940). A sudden drop in the high tones, however, is pathognomonic of a nerve deafness, as is of course "recruitment of loudness" (see footnote).

But to ascertain these things one must use an audiometer in a sound-proofed room. Is this necessary?

It is generally agreed that the most important function of the ears is the reception of speech, and it is agreed that testing with voice and whisper in the ordinary way is inaccurate because it can hardly be reproduced minute to minute, certainly it cannot be reproduced from day to day or from individual to individual. But the voice may be satisfactory for certain quantitative tests if it is controlled by mechanical devices. A device of this type is the gramophone audiometer, usually used for testing several persons at one time (Fowler and Fletcher, 1926). The records from this machine can be placed on an ordinary spring-driven gramophone and, except for the scratch of the needle and the mechanical quality of the voice, it is a fairly satisfactory way to compare hearing aids.

A better method is to use a sound level meter in a quiet room (see fig 2). With a little practice, watching the voltmeter of this apparatus, one can govern the intensity of the voice so that the summation of the power put out does not vary more than two or three decibels for a spoken number or other selected words and not more than five decibels for unselected words. If a mistake is made and the voice is inadvertently raised or lowered more than a few decibels from the level desired, that particular test word can be discounted. Using this apparatus, it is interesting to note that the untrained speaker lowers his voice for certain numbers such as 50 and 60 and raises his voice for 40 and 4, &c. Watching such an instrument efficiently shows up many other discrepancies which used to bother us while comparing hearing aids. It is most instructive to watch an untrained examiner for example raise his voice instinctively as he moves away from the patient so that at 10 or 12 feet distance the decibel meter indicates the same degree of loudness reaches the patient as at 2 or 3 feet distance. The prospective hearing aid customer is of course delighted at the distance at which he can hear the examiner, but as a rule, tests of this type give a false impression of the actual improvement in hearing obtained. For the testing of hearing aids a sound level meter is more useful than the gramophone audiometer because the voice is more natural and the patient can judge the quality of the tone reception.

A third method for evaluating the capacity to hear speech is to interpolate the threshold audiogram for speech. This is the best method for the average otologist. If he has a threshold audiogram for air and bone conduction it is most useful for

<sup>1</sup> Recruitment of loudness is a phrase that has been coined by Fowler (1936, 1937) for the phenomenon exhibited by nerve-deafened patients provided their deafness is not complete. It is best illustrated by loudness balance tests on a patient who has normal hearing on one side and a nerve-deafened ear, for one or more notes, on the other. If the sound of a given note is binaurally balanced in 5 to 10 db steps it will be found that the patient will hear the sound in the nerve-deafened ear at the same loudness as in the normal ear soon after the threshold is passed in the deafened ear. The balance point will usually be not more than 5 to 15 db above this threshold. After this, no matter what the loudness, sounds will be heard just as loud by the nerve-deafened ear as by the normal ear. If the nerve deafness involves several high notes and a single high tone is used for the test, the patient may remark, when a loudness balance has been reached, that the test sound does not have the same pitch in the two ears but that it is equally loud.

It can be deduced, from the experiments mentioned above, where a normal ear is used for control of a deafened ear in the same patient, that nerve-deafened patients must hear loud sounds with the same intensity as normal persons soon after their threshold is passed, even if both their ears are deafened. It is a well-known fact that elderly people, with nerve deafness, one moment do not hear speech and the next moment complain that a speaker is shouting at them, when actually the voice has been raised very little.

The probable explanation for the recruitment of loudness phenomenon is that the 8th nerve and its end-organs work by the "all or none" law just like any other nerve. It is thought to be due to a "recruitment" of nerve fibres elsewhere in the cochlea than at the optimum resonance point.

vowels but not the weak high-pitched consonants so they could not *understand* speech unless it was over their threshold. Then, due to recruitment, they heard very well.

Ordinary speech in a quiet room reaches the human ear at a level varying from 30 to 60 db, making an average of 45 db over normal threshold. It can be well understood only about 15 db below this level, i.e. 30 db. From tables in Fletcher's book (1929), *Speech and Hearing*, fig. 127, page 272, it can be seen that 78% of articulation is correctly interpreted when heard at an average level of 30 db above normal threshold. But at 25 db above normal threshold only 30% of articulation is correctly interpreted and at this level or below, speech is of course so unintelligible as to be useless. All thresholds are raised by room noise. These facts are useful in ascertaining whether a given patient can successfully wear a hearing aid. Another example is given in Patient (C), fig. 4, who had a conduction deafness of about 40 db; she was a girl of 21 who probably had otosclerosis. She gets a great deal of satisfaction from a hearing aid which seems to work at all distances. Patient (D) was a man of 56 with a nerve deafness of unknown cause. One ear's threshold audiogram is of the same order as that of Patient (C) but he gets no help from a hearing aid for ordinary use because he must adjust it very delicately for distance and the voice of the speaker. As a matter of fact he gets on very well most of the time in spite of his deafness; while Patient (C) is markedly handicapped without a hearing aid. The reason for this is that Patient (C) must have spoken voice reach her ear at least 40 db above the normal 30 db average threshold for articulation. This means that she must have speech amplified to an average of 70 db above threshold before she can understand it in a quiet room. Patient (D) also has a 40 db deafness, but it is a nerve deafness and due to recruitment he needs only to have speech amplified 7 to 10 db in order for him to hear it just as loud as does a normal individual.<sup>1</sup> This means that he only needs to have speech amplified to a minimum of 47 to 50 db which is very little louder than the average for ordinary speech in a quiet room. If it is less loud than this he may still hear enough to understand. Most of us speak very much more loudly than the minimum necessary for the speech to be understood and usually we do not speak in a quiet place so that we often speak at an average level of 55 to 75 db. Patient (D) lived and worked in an environment which allowed him to get along pretty well and therefore the expense involved in buying and keeping up a hearing aid is hardly justified in his case in spite of the fact that his threshold audiogram for air conduction appears to be the same as that of Patient (C).

For the above examples, I have selected patients with fairly pure nerve deafness or conduction deafness. If a patient had a mixed deafness, a hearing aid would have to be fitted with both the impedance in the middle ear, and the recruitment of loudness of the inner ear, in mind. If a conduction deafness component is present it is never overcome so that there is never complete recruitment of loudness. Air conduction hearing aids of the modern vacuum type are much more efficient than bone conduction aids and it is also much easier to change their frequency characteristics. The only patients who prefer bone conduction to air conduction hearing aids are those in which there is a marked impedance in the middle ear and little superimposed nerve deafness, i.e. those who have exceptionally good bone conduction. The only reason that hearing aid companies have been able to exploit bone conduction aids with such marked success has been that conduction deafness is very common and the uninitiated patient feels that if a bone conduction aid has helped a friend it must necessarily help him.

No discussion on the fitting of hearing aids is complete unless we discuss the patients for whom no hearing aid, or at least no electrical hearing aid so far invented, is suitable. These fall into two classes. (1) No patient with a deafness which, on the average, is less than 30 db above normal threshold for the speech range will be helped by a hearing aid. (2) If he has a deafness over 85 db for this range, he will rarely be helped unless he has worn a hearing aid while his deafness was less pronounced.

Strangely enough, very hard of hearing patients can use the old-fashioned speaking tube with considerable benefit. They are often elderly people who are frightened by the mechanics of adjusting a complicated electrical device. It is often wise to recommend a speaking tube for very deaf individuals at once, rather than to fuss with a machine which is bound to be unsatisfactory.

Otologists should also acquire the technique of "selling" the idea of wearing a hearing aid to the patient. It must be remembered that the patient comes to the physician for medical advice. The prescriber of a hearing aid should know the hearing-aid dealers in his locality and the types of instruments available. It must be remembered that many patients receive a profound psychological shock when a hearing aid is prescribed. They have been known to commit suicide. It is rarely advisable to definitely advise a

<sup>1</sup> The 7 to 10 db is deduced from observations on patients with a similar deafness in one ear and normal hearing on the other. Recruitment of loudness was discussed in the previous footnote.

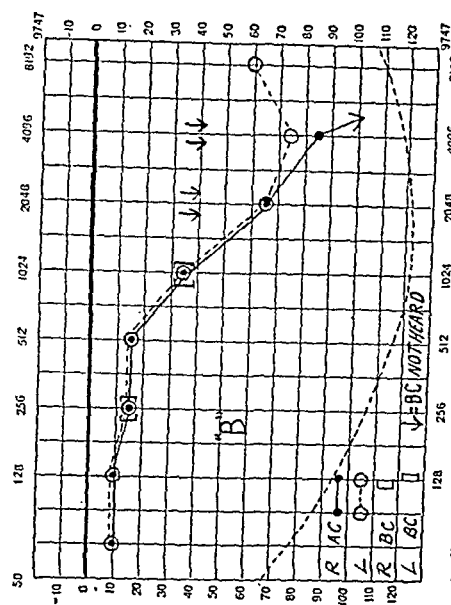


FIG. 1A.—Audiogram of a 70-year-old man with a high tone loss due to quinine, who misses low notes heavily damped and gets help from a hearing aid only at fixed distances. Even with the highest quality hearing aids make some sounds unpleasantly loud. This man could not profitably wear a hearing aid.

FIG. 1B.—Audiogram of a 73-year-old man with only slightly greater loss in hearing than A, who gets considerable help from a hearing aid. He also has a nerve deafness probably due to quinine. Note the difference in the audiograms is almost entirely at 1024 and 2048. His aid damps all but these notes.

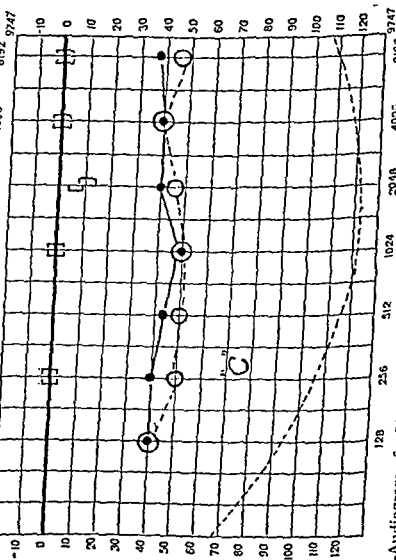


FIG. 1C.—Audiogram of a 21-year-old girl with probable otosclerosis, who wears an air conduction hearing aid with tremendous benefit.

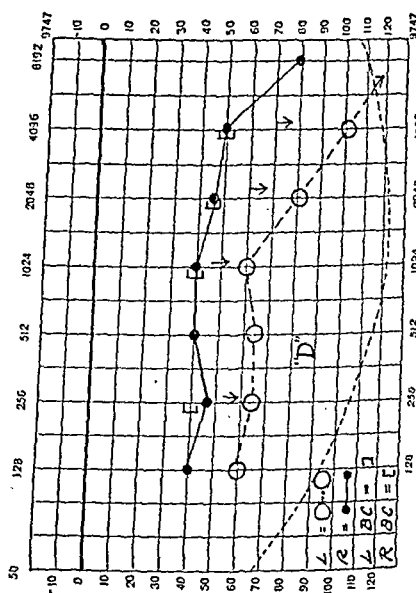


FIG. 1D.—Audiogram of a 54-year-old man with nerve deafness, etiology unknown, who has about the same air conduction hearing as A, but with a different pattern of loss. He gets no benefit from an air conduction hearing aid, but with a bone conduction hearing aid he gets a hearing aid in articulation, but not in articulation. He also has a nerve deafness, probably due to quinine. Note the difference in the audiograms is almost entirely at 1024 and 2048. His aid damps all but these notes.

The test now in use is the ability to hear the forced whisper at 20 ft. in each ear. This has long been recognized as being inaccurate and inconsistent as a measure of the capacity for hearing under flying conditions. There are many variable factors in the technique of this test. These include such things as background noise, the voice of the examiner, or the place in which the test is conducted. Each ear is tested separately and if a hearing defect is found in one it is assumed that the candidate cannot hear efficiently under flying conditions through telecommunication channels. This is not necessarily true, as the test so performed and interpreted is not a fair test of the actual hearing efficiency of the person. It is certainly desirable not to accept candidates whose auditory defect is such that will prevent them from hearing efficiently their Radio-telephony, Inter-communication or Wireless telegraphy; at the same time it is a waste of good material to reject those who do not strictly come up to the 20 ft. forced whisper test.

An attempt has been made to make a test for the efficiency of hearing, reproducing Service conditions as nearly as possible. In the new test the number of variables is reduced so that the results may be comparable when the test is carried out by different observers at different places. Pure tone audiometry, though accurate, is time-consuming when a large number of candidates have to be examined. Acoustic conditions are not standard and consequently results are variable. Even assuming that a candidate has a normal audiogram it does not tell us whether he will be able to interpret speech under noisy conditions such as he will meet in modern aircraft. Intelligence, aptitude, receptive powers and listening are essential factors.

The basis of our proposed tests consists of two parts: (1) A test for overall capacity to hear speech in the presence of noise using both ears at once. This we can call the efficiency test.

(2) A test designed to show the amount and type of hearing defect in each ear separately. This will be a modified form of audiometric examination and will give a rough estimate of a subject's threshold at four different frequencies. This will be known as the pure tone test.

*Application of the new tests.*—The suggested application of the new tests is as follows, although experience may show that modifications are necessary:

- (i) All who pass the efficiency test are fit for some form of flying duties as regards hearing *per se*, though they may of course be rejected on the grounds of certain aural diseases such as active C.S.O.M., or otosclerosis. Thus candidates either pass or fail as far as the efficiency test is concerned, and there are no intermediary grades.
- (ii) By means of the pure tone test the candidates who have passed the efficiency test are divided into two groups, "A" and "B". Group "A" will consist of those who are shown to have normal hearing in both ears. In addition it will include those candidates who show some hearing loss, but whose results, taken in conjunction with the clinical examination, suggest that there is no greater chance of their hearing efficiency deteriorating during flight than in the case of a "normal" subject. Group "B", on the other hand, will contain all those subjects who pass the efficiency test and satisfy the clinical examination, but who do not come up to the requirements of Group "A".

It is suggested that those in Group "A" are eligible for employment where the highest auditory acuity is required. Group "B" would be eligible for any other form of flying duties.

*Detection of deterioration of hearing during Service life.*—By means of the pure tone test a permanent record of the hearing in each ear can be made for comparison with the hearing on a future occasion. This would be a more accurate basis of comparison than any now available. If applied to the candidate on selection and then at any time during his flying career it forms an easy method for assessing any gross deterioration that may have occurred in the interval.

#### DESCRIPTION OF THE TESTS

*The efficiency test.*—In this test, speech is sent into a pair of telephones worn by the candidate and he is asked to write down what he hears. The speech is accompanied by a high level of background noise which approximates in intensity and spectrum to the noise heard in aircraft. This background noise serves two purposes. Its primary object is to help simulate the conditions in which the candidate will have to work if accepted for aircrew duties. In addition it serves to mask any ambient noise which may be present when the test is carried out. The speech material used consists of lists of English monosyllables dictated to the candidate. These word lists have been carefully compiled to give an adequate representation of the sounds which occur in current English speech. Experimental work has shown that the ability to perform such a sound articulation test is closely correlated with the ability to receive sentences.

The test is marked by counting the number of sounds (not words) which are correctly recorded by the candidate. The telephones worn by the candidate are mounted in a Service pattern headband fitted with sound-excluding ear pads. The word lists are delivered to both ears of the candidate.

In the prototype equipment, provision is made for the testing of ten people at one time, but switches are provided so that, if necessary, fewer than ten can be tested without affecting the strength of signal delivered to each pair of telephones.

*The pure tone test.*—This is designed to give a very gross estimate of the pure tone audiogram of the candidate. Pure tones of different frequencies are recorded at different intensities on gramophone discs. The pure tone signals are reproduced at the candidate's ear by means of the same replay system as used for the "efficiency test". In this test the candidate uses only one ear at a time and switches are provided for changing the signal from the candidate's right ear to his left.

As a result of examining something like 3,000 candidates certain broad facts have become apparent, viz.,

- (1) Those with a conductive form of deafness involving mainly the middle frequencies, provided the deafness is not too severe, generally do well on the efficiency test, even though their hearing does not come up to the required 20 ft. F.W.



hearing aid upon the first visit of a strange patient, unless he specifically comes to a physician for help in the selection of an aid. Confidence in the physician must be established before what most patients consider a drastic step, is promulgated. It is good policy to have a high quality aid in the office. A semi-portable one with base and treble adjustment and which works on house current, is usually the best for this purpose. Some audiometer manufacturers attach a microphone to the amplifier in their instruments. This sort of hook-up is, to all intents and purposes, a high quality hearing aid. Either method is useful in acousting a patient to amplified sound, and, incidentally, reduces the strain upon the examiner's voice.

Usually it is better to recommend a lip-reading teacher before recommending a hearing aid because few patients will learn lip-reading after they have acquired hearing aids. Incidentally, here again it is wise to recommend a specific teacher or class and if possible make an appointment for the patient or the advice will often be ignored. Finally, when the physician is sure that the idea of a hearing aid will be accepted, the arrangements for procuring one are begun. Meanwhile two or three audiograms have been obtained so that a knowledge of the fluctuation of the patient's hearing is available. The improvement of hearing with the office microphone hearing aid is discussed and perhaps re-demonstrated. The probable type of instrument for the patient's hearing loss is decided upon and the names and addresses of not more than three, preferably only two, hearing-aid companies are given to the patient. The approach is, now, not whether the patient should obtain the hearing aid but which of the two types of instruments is more suitable. A final check of the instrument selected should be made by the physician before it is purchased. Dealers who are not co-operative in sending their instruments to the office so that comparisons on the final selection can be made are not likely to get sales through physicians. Fortunately the differences in mechanics of the higher quality hearing aids do not vary much and the final selection of the patient often depends upon the shape of the case in which the mechanism is mounted or the personality of the salesman who demonstrated it rather than an actual difference in performance. It will be noted that the patient is sent to the dealer rather than having all of the adjustments made in the office of the physician himself. It is too time-consuming for a busy surgeon to try all the possible combinations of amplifier, receiver and battery power. As a rule, the dealer can put together the most satisfactory combination in a shorter time. They are always more familiar with the mechanical characteristics of their own instruments.

The physician should also make, or have his assistant make, the plaster cast of the external auditory meatus which is so essential for the efficient performance of the modern air conduction hearing aid. Because this has been left to dentists and hearing-aid salesmen, several accidents have occurred. There is one case on record where plaster was poured through a perforation in the drum and a radical mastoidectomy was necessary in order to remove it from the middle ear.

Testing of hearing, psychological approach and knowledge of the hearing-aid field and the making of casts are not enjoyed by some otologists. The whole procedure is very much like the fitting of contact lenses and will therefore probably be done by those who are particularly inclined toward this type of work. We should all look forward to the day when hearing aids are fitted as efficiently and worn just as casually as are spectacles.

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#### SUGGESTED NEW HEARING TEST

Air Commodore E. D. D. DICKSON: Hearing tests applied for the selection of Service flying personnel are based on experimental work which has been in progress for some time in the Acoustic Laboratory of the Ear, Nose and Throat Department, Central Medical Establishment.

of every type. Suitable preventive measures for those operating various weapons have still to be found and adequate steps taken to keep as low as possible the number who will have just claims for pensions for damaged ears after the war.

It may be asked why more was not done, firstly to keep the aural unfits out of the Army, secondly to provide hearing standards that were a measure of a man's auditory acuity and of use for comparative purposes at all times (instead of the present standards which are an insult to any self-respecting otologist); and thirdly to place men in employment within the Service appropriate to the condition of their ears. There are many reasons why none of these things have been done but they are not relevant to the subject under discussion and they will not be elaborated. I will, however, remind you that, rightly or wrongly, the admission to the Army of men with certain aural defects has from time to time been determined by the need for men in the Services and the man-power available to meet this need. As for the Hearing Standards, these were intended as a guide for Civilian Medical Boards and Unit Medical Officers and were never designed for use by specialist otologists. Will those of you who have been humiliated by terse notes from battalion medical officers demanding the standard of hearing or medical category please accept apologies.

The correct placing of men with ear disabilities in the various arms and in suitable jobs within those arms, is perhaps the most important problem. As no attempt to solve this problem was made prior to or during the first years of the war, a wholesale sorting out at this stage would almost demand a temporary cessation of hostilities while it were accomplished. Many and varied suggestions for employing the deaf and partially deaf have been made. One combatant officer produced a scheme in great detail for the formation of a deaf battalion in order that those so afflicted might make their just contribution to the war effort. Working on the assumption that many of the horrors of war were the result of noise it appeared to him that there were many advantages in being deaf. Likewise if men had learnt to depend on sight and their other special senses they would be more alert than those who waited to hear something. The scheme was praiseworthy and ingenious but not practicable.

Another line of approach suggested is systematically to test audiometrically the personnel of individual units and then rearrange the duties according to each individual's ability to hear. An audiogram has an almost magical effect on the layman and many unwilling commanding officers will readily co-operate, however great the inconvenience, once the significance of this mysterious chart has been explained to them. The lack of audiometers and a fear of the chaos which might follow their unrestrained use prevented this suggestion materializing.

There is, however, not the slightest doubt that more careful aural selection early on, and to some extent at the present time, of personnel for certain units would have resulted in greater efficiency. Investigations are at present being undertaken to collect reliable data on which to base recommendations for the selection and protection of R.A. personnel. It is hoped these researches will be fruitful and the results suitable for publication in due course, but we are resolved to have facts and not impressions before advice is given.

The advance of specialization has led to such careful analysis of the individual soldier that he is in grave danger of being assessed in terms of his separate systems and senses, while the composite human being receives scant attention. "He is no longer an individual man but a jumble of scientific data."

This is the view held by certain senior administrative officers and much evidence can be produced to support it. Modern warfare is most intricate and highly technical and specialists of every type are essential to the present-day Army. In the selection of these specialists much help can be derived from the wise application of medical knowledge. At the same time it is of prime importance that the first function of the Royal Army Medical Corps should not be forgotten, namely "to provide for the General Staff the maximum number of fit men". I have still to be convinced that pure tone audiometry is essential to enable us to carry out this function.

Mr. IAN G. ROBIN wished to ask with regard to binaural aids whether Major Fowler had found it useful to put in a constant masking tone in the more deaf ear. He had had several patients who had been able to hear with that device very well indeed, much better than with anything else.

He had the greatest difficulty in correlating his audiometric readings with speech sounds, whispered and conversation. One could produce many audiometric charts which looked exactly the same, yet the response to speech tests was different and the response to hearing aids was different. One patient would do better with a valve amplifier, while a few would prefer a micro-telephone with an air conduction ear piece.

Squadron-Leader D. B. FRY agreed very much with Major Fowler as to the importance of the phenomenon which Dr. Fowler, Sr., has called "recruitment", and the questions he wished to ask concerned recruitment. In the first place he understood Major Fowler to say that in most cases of nerve deafness he had found that the equal loudness level was reached soon after the threshold of the deafened ear had been passed—he thought he mentioned something like 10 to 15 db. Major Fowler was probably familiar with the work of Steinberg who mentioned in his paper cases in which the equal loudness level was certainly not reached within 10 to 15 db of the threshold but was somewhat higher. Had Major Fowler any information as to how frequent such cases were?

Another point, also from Steinberg's work, was that although there was this recruitment of loudness by which the deafened ear would hear a sound as being equally loud with that in the undeafened ear at a certain level, there was not, apparently, any recruitment of speech articulation, and Steinberg rather suggested that the curve for speech articulation was exactly, or very much, like the loudness matching curve for conductive deafness; the articulation remained below the normal by an almost constant amount. Had Major Fowler's experience borne that out and if so, what was the bearing of this on the design of hearing aids?

Major Fowler also said that the untrained speaker tended to lower his voice, for

- (2) Those with a high tone loss, however, often show difficulty and give lower scores than normal ears.

Pure tone audiometry with a Western Electric 6A audiometer was carried out in the majority of the cases falling under the above classifications.

- (3) We have gained the impression, which requires confirmation, that some cases with recent damage in one ear have obtained lower scores in the efficiency test than other cases with long-standing damage in one ear. Is it possible that this damage to one ear can cause a distortion of the centrally received pattern and that with the passage of time the subject learns to disregard this distortion so that the interpretation of the pattern is not interfered with, rather in the manner in which an image from one eye can be suppressed?

Is there a "fusion effect" when listening with both ears? Can defect in one ear under certain conditions upset the pattern which is projected centrally for interpretation?

Mr. TERENCE CAWTHORNE: In considering the relationship of audiometry to the prescribing of hearing aids I feel, like Major Fowler, that the audiogram gives us a useful general picture of the hearing from which we can make a rough estimate of the possible help that is likely to be given by an aid, and which can be used as a yardstick against which other tests and claims can be measured. Unfortunately it is not possible to prescribe an aid whose response curve will fit the hearing curve of the audiogram like two neighbouring pieces of a jigsaw puzzle. The ideal hearing aid would be one giving a flat response that could be varied to fit the hearing loss by employing filters so as to cut out or reduce certain wave bands. Something like this has been attempted, but the limitation of size and the relatively poor performance of most earpieces, especially for the higher tones, makes accurate prescribing nothing more than a hope for the future.

In performance the valve aid surpasses all others and the range of amplification that it offers more than compensates for the size, cost and upkeep. The modern valve aid with crystal microphone and earpiece is indeed a very great advance and enables us to say with confidence to many of our deafened patients that they will be able to hear again. I am sure that the wider field of amplification of the valve aid has improved the attitude of the patient towards hearing aids. Until recently it demanded all our powers of persuasion to get a patient even to consider using a valve aid because of its size. I think that the improved performance of the valve aid accounts for the more tolerant attitude of the hard of hearing towards conspicuous aids.

Although performance curves show the valve instrument to be the aid of choice, some patients prefer a non-electrical aid. It is difficult to understand why this should be and herein lies the danger in relying too much on the results of pure tone tests. It is only by speech tests in accustomed as well as unaccustomed surroundings that the true value of a hearing aid can be assessed, and I think that the value of the non-electrical aid lies in the fact that it cuts out all unwanted sounds rather than in the modest degree of amplification that it gives. The battery driven aid with bone conduction receiver cannot at present be compared with the valve aid. Its performance is governed by the poor response of the bone conduction receiver and in my experience a good air conduction receiver always gives better results, although for short distance hearing the bone conduction receiver may for aesthetic reasons be preferred by the patient. It is of importance to know for what purpose a patient requires his hearing. For short distance hearing, the less efficient types of electrical aid such as the battery-driven aid with air or bone conduction receiver may enable a patient with conduction deafness to follow conversation, but for long distance hearing such as at church, meetings or entertainments, nothing but a valve aid is likely to be of any real value.

The not unnatural dislike of having to wear a conspicuous earpiece and of disposing an aid about the person has kept the deafened public back from using good hearing aids, but the increased help that the modern valve aid can give has gone far to overcome any prejudice on the part of the deafened and their employers.

It is essential that in the urge for reduction of size of aids we as otologists should insist that performance is not allowed to suffer.

The establishment of hearing aid clinics in this country was stimulated by the work of the late Dr. Phyllis Kerridge and the success of her clinic at University College Hospital showed the need for such organizations, of which several have been established since. One of the problems that will confront us after the war will be the establishment of hearing aid clinics throughout the country that will enable the hard of hearing to get help and advice in the selection, purchase and servicing of a hearing aid.

#### THE STANDARDS OF HEARING AND AURAL FITNESS REQUIRED BY THE ARMY

Lieut.-Colonel MYLES L. FORMBY, Adviser in *Oto-Rhino-Laryngology to the Army*: It is possible that the appointment before the war of an Adviser in Otology with a wide experience of Army requirements, an up-to-date knowledge of field equipment and an inkling of the developments that were to follow would have enabled the Army Medical Department to recommend auditory standards to meet all contingencies. The auditory acuity of all recruits would have been measured prior to enlistment and each could have been placed in the Service according to his capabilities. All the "chronic otorrheas" would have been eliminated and apart from the incidental "acute otitis" all soldiers would now be otologically fit. The lot of the military otologist would then indeed have been a happy one and he would have been even more envied by his civilian colleagues than is the case at present.

It is not my intention to convey to you the impression that I am a defeatist; that I regard the present position as satisfactory; that I do not consider there is any real problem to solve; or, finally, that the aurally unfit soldier should not receive proper care and consideration. On the contrary there is much to be done, and I hope will be done, to improve our present methods of treatment, classification and disposal of ear cases

of every type. Suitable preventive measures for those operating various weapons have still to be found and adequate steps taken to keep as low as possible the number who will have just claims for pensions for damaged ears after the war.

It may be asked why more was not done, firstly to keep the aural unfits out of the Army, secondly to provide hearing standards that were a measure of a man's auditory acuity and of use for comparative purposes at all times (instead of the present standards which are an insult to any self-respecting otologist); and thirdly to place men in employment within the Service appropriate to the condition of their ears. There are many reasons why none of these things have been done but they are not relevant to the subject under discussion and they will not be elaborated. I will, however, remind you that, rightly or wrongly, the admission to the Army of men with certain aural defects has from time to time been determined by the need for men in the Services and the man-power available to meet this need. As for the Hearing Standards, these were intended as a guide for Civilian Medical Boards and Unit Medical Officers and were never designed for use by specialist otologists. Will those of you who have been humiliated by terse notes from battalion medical officers demanding the standard of hearing or medical category please accept apologies.

The correct placing of men with ear disabilities in the various arms and in suitable jobs within those arms, is perhaps the most important problem. As no attempt to solve this problem was made prior to or during the first years of the war, a wholesale sorting out at this stage would almost demand a temporary cessation of hostilities while it were accomplished. Many and varied suggestions for employing the deaf and partially deaf have been made. One combatant officer produced a scheme in great detail for the formation of a deaf battalion in order that those so afflicted might make their just contribution to the war effort. Working on the assumption that many of the horrors of war were the result of noise it appeared to him that there were many advantages in being deaf. Likewise if men had learnt to depend on sight and their other special senses they would be more alert than those who waited to hear something. The scheme was praiseworthy and ingenious but not practicable.

Another line of approach suggested is systematically to test audiometrically the personnel of individual units and then rearrange the duties according to each individual's ability to hear. An audiogram has an almost magical effect on the layman and many unwilling commanding officers will readily co-operate, however great the inconvenience, once the significance of this mysterious chart has been explained to them. The lack of audiometers and a fear of the chaos which might follow their unrestrained use prevented this suggestion materializing.

There is, however, not the slightest doubt that more careful aural selection early on, and to some extent at the present time, of personnel for certain units would have resulted in greater efficiency. Investigations are at present being undertaken to collect reliable data on which to base recommendations for the selection and protection of R.A. personnel. It is hoped these researches will be fruitful and the results suitable for publication in due course, but we are resolved to have facts and not impressions before advice is given.

The advance of specialization has led to such careful analysis of the individual soldier that he is in grave danger of being assessed in terms of his separate systems and senses, while the composite human being receives scant attention. "He is no longer an individual man but a jumble of scientific data."

This is the view held by certain senior administrative officers and much evidence can be produced to support it. Modern warfare is most intricate and highly technical and specialists of every type are essential to the present-day Army. In the selection of these specialists much help can be derived from the wise application of medical knowledge. At the same time it is of prime importance that the first function of the Royal Army Medical Corps should not be forgotten, namely "to provide for the General Staff the maximum number of fit men". I have still to be convinced that pure tone audiometry is essential to enable us to carry out this function.

Mr. IAN G. ROBIN wished to ask with regard to binaural aids whether Major Fowler had found it useful to put in a constant masking tone in the more deaf ear. He had had several patients who had been able to hear with that device very well indeed, much better than with anything else.

He had the greatest difficulty in correlating his audiometric readings with speech sounds, whispered and conversation. One could produce many audiometric charts which looked exactly the same, yet the response to speech tests was different and the response to hearing aids was different. One patient would do better with a valve amplifier, while a few would prefer a micro-telephone with an air conduction ear piece.

Squadron-Leader D. B. FRY agreed very much with Major Fowler as to the importance of the phenomenon which Dr. Fowler, Sr., has called "recruitment", and the questions he wished to ask concerned recruitment. In the first place he understood Major Fowler to say that in most cases of nerve deafness he had found that the equal loudness level was reached soon after the threshold of the deafened ear had been passed—he thought he mentioned something like 10 to 15 db. Major Fowler was probably familiar with the work of Steinberg who mentioned in his paper cases in which the equal loudness level was certainly not reached within 10 to 15 db of the threshold but was somewhat higher. Had Major Fowler any information as to how frequent such cases were?

Another point, also from Steinberg's work, was that although there was this recruitment of loudness by which the deafened ear would hear a sound as being equally loud with that in the undeafened ear at a certain level, there was not, apparently, any recruitment of speech articulation, and Steinberg rather suggested that the curve for speech articulation was exactly, or very much, like the loudness matching curve for conductive deafness; the articulation remained below the normal by an almost constant amount. Had Major Fowler's experience borne that out and if so, what was the bearing of this on the design of hearing aids?

Major Fowler also said that the untrained speaker tended to lower his voice, for

- (2) Those with a high tone loss, however, often show difficulty and give lower scores than normal ears.

Pure tone audiometry with a Western Electric 6A audiometer was carried out in the majority of the cases falling under the above classifications.

- (3) We have gained the impression, which requires confirmation, that some cases with recent damage in one ear have obtained lower scores in the efficiency test than other cases with long-standing damage in one ear. Is it possible that this damage to one ear can cause a distortion of the centrally received pattern and that with the passage of time the subject learns to disregard this distortion so that the interpretation of the pattern is not interfered with, rather in the manner in which an image from one eye can be suppressed?

Is there a "fusion effect" when listening with both ears? Can defect in one ear under certain conditions upset the pattern which is projected centrally for interpretation?

Mr. TERENCE CAWTHORNE: In considering the relationship of audiometry to the prescribing of hearing aids I feel, like Major Fowler, that the audiogram gives us a useful general picture of the hearing from which we can make a rough estimate of the possible help that is likely to be given by an aid, and which can be used as a yardstick against which other tests and claims can be measured. Unfortunately it is not possible to prescribe an aid whose response curve will fit the hearing curve of the audiogram like two neighbouring pieces of a jigsaw puzzle. The ideal hearing aid would be one giving a flat response that could be varied to fit the hearing loss by employing filters so as to cut out or reduce certain wave bands. Something like this has been attempted, but the limitation of size and the relatively poor performance of most earpieces, especially for the higher tones, makes accurate prescribing nothing more than a hope for the future.

In performance the valve aid surpasses all others and the range of amplification that it offers more than compensates for the size, cost and upkeep. The modern valve aid with crystal microphone and earpiece is indeed a very great advance and enables us to ear with confidence to many of our deafened patients that they will be able to hear again. I am sure that the wider field of amplification of the valve aid has improved the attitude of the patient towards hearing aids. Until recently it demanded all our powers of persuasion to get a patient even to consider using a valve aid because of its size. I think that the improved performance of the valve aid accounts for the more tolerant attitude of the hard of hearing towards conspicuous aids.

Although performance curves show the valve instrument to be the aid of choice, some patients prefer a non-electrical aid. It is difficult to understand why this should be and herein lies the danger in relying too much on the results of pure tone tests. It is only by speech tests in accustomed as well as unaccustomed surroundings that the true value of a hearing aid can be assessed, and I think that the value of the non-electrical aid lies in the fact that it cuts out all unwanted sounds rather than in the modest degree of amplification that it gives. The battery driven aid with bone conduction receiver cannot at present be compared with the valve aid. Its performance is governed by the poor response of the bone conduction receiver and in my experience a good air conduction receiver always gives better results, although for short distance hearing the bone conduction receiver may for æsthetic reasons be preferred by the patient. It is of importance to know for what purpose a patient requires his hearing. For short distance hearing, the less efficient types of electrical aid such as the battery-driven aid with air or bone conduction receiver may enable a patient with conduction deafness to follow conversation, but for long distance hearing such as at church, meetings or entertainments, nothing but a valve aid is likely to be of any real value.

The not unnatural dislike of having to wear a conspicuous earpiece and of disposing an aid about the person has kept the deafened public back from using good hearing aids, but the increased help that the modern valve aid can give has gone far to overcome any prejudice on the part of the deafened and their employers.

It is essential that in the urge for reduction of size of aids we as otologists should insist that performance is not allowed to suffer.

The establishment of hearing aid clinics in this country was stimulated by the work of the late Dr. Phyllis Kerridge and the success of her clinic at University College Hospital showed the need for such organizations, of which several have been established since. One of the problems that will confront us after the war will be the establishment of hearing aid clinics throughout the country that will enable the hard of hearing to get help and advice in the selection, purchase and servicing of a hearing aid.

#### THE STANDARDS OF HEARING AND AURAL FITNESS REQUIRED BY THE ARMY

Lieut.-Colonel MYLES L. FORMBY, Adviser in Oto-Rhino-Laryngology to the Army: It is possible that the appointment before the war of an Adviser in Otology with a wide experience of Army requirements, an up-to-date knowledge of field equipment and an inkling of the developments that were to follow would have enabled the Army Medical Department to recommend auditory standards to meet all contingencies. The auditory acuity of all recruits would have been measured prior to enlistment and each could have been placed in the Service according to his capabilities. All the "chronic otorrhœas" would have been eliminated and apart from the incidental "acute otitis" all soldiers would now be otologically fit. The lot of the military otologist would then indeed have been a happy one and he would have been even more envied by his civilian colleagues than is the case at present.

It is not my intention to convey to you the impression that I am a defeatist; that I regard the present position as satisfactory; that I do not consider there is any real problem to solve; or, finally, that the aurally unfit soldier should not receive proper care and consideration. On the contrary there is much to be done, and I hope will be done, to improve our present methods of treatment, classification and disposal of ear cases

## Section of Neurology

President—R. M. STEWART, M.D.

[*March 18, 1943*]

**Contrast Media in Lesions of the Cerebral Hemisphere.**—Major EDGAR A. KAHN, U.S. Army:

It has been the experience of all neurosurgeons in attempting ventricular oxygen injection or biopsy of a cerebral tumour unexpectedly to enter a cystic cavity with the exploring needle, xanthochromic fluid or pus being obtained. To approach such a lesion in the most direct manner and thus simplify the operative procedure, a contrast medium is desirable. Thorotrast is to all intents and purposes non-irritating in closed cavities, is readily miscible with fluid contents and has the added advantage in cerebral abscesses of being phagocytized by the cellular elements of the capsule making it radio-opaque.

CASE I.—Otogenic abscess in a 12 year old boy. The abscess was tapped at a depth of 4.5 cm. and 6 c.c. of thorotrast instilled. A small decompression was made directly over the abscess cavity as visualized by X-ray. Within three days the capsule itself was visualized by phagocytized particles of thorotrast. The abscess rose to the surface where it spontaneously extruded. The migration was followed over a period of fourteen days by X-ray.

CASE II.—Abscess which developed beneath a previously drained subdural abscess. A large bony defect was present and the abscess might have been anywhere beneath. It was advantageous to visualize this abscess directly so that it could be drained where it lay most superficially. The abscess has definitely increased in size over the period of four days before drainage was effected.

CASE III.—Deep-seated abscess in which thorotrast was instilled. The abscess was later evacuated by open drainage. The phagocytized thorotrast in the collapsed capsule is seen. So far as I know this has produced no reaction and the patient was back at work when last I heard. The deeper an abscess the more difficult is its drainage. Especially is this true in the cerebral hemisphere. The lowermost portion of the capsule in this case lay within 1 cm. of the posterior clinoid process. The value of a contrast medium in such a case is apparent.

CASE IV.—Abscess metastatic from the lung. These abscesses are caused by a mixed infection and do not tend to encapsulate but enlarge by destruction of brain tissue. They are quite common in cases of pulmonary abscess. Those attributed to empyema or bronchiectasis are due to pulmonary abscesses adjacent to the empyema or bronchiectatic cavity. Major Robert Shaw, our thoracic surgeon, offers the following reason why a pulmonary abscess is prone to metastasize to the brain and not to other parts of the body: when the embolus from the abscess cavity breaks into the pulmonary circulation a certain amount of air enters with it and the rising air carries the embolus cephalad. Though I have seen a number of these cases on the Thoracic Surgery Service at the University of Michigan Hospital, I have yet to cure one.

CASE V.—Thorotrast in a cystic glioblastoma multiforme. Cyst formation is common in the glioblastoma multiforme, and is undoubtedly due to central necrosis within the tumour itself. Consequently the cavity is surrounded by solid or semi-solid necrotic tumour and the wall is poorly defined. On surgical incision into such a tumour the cavity tends to be obliterated by the rapid expansion on all sides of the broken down oedematous, discoloured tumour tissue. One might draw a comparison between this lesion and the unencapsulated abscess of the brain secondary to pulmonary suppuration. Both form their cavities by a process of liquefaction necrosis without any tendency towards walling off; there is similarly a certain resemblance as shown by contrast media.

CASE VI.—Thorotrast in a cystic astrocytoma. The ventriculogram suggested that the lesion was of considerable size, and judging from air studies alone to have exposed it completely would have meant turning down a large bone flap. Cushing showed long ago that if the mural nodule of an astrocytoma were removed the cyst wall need not be dealt with. By accurately visualizing the mural nodule with thorotrast an effective operation was completed by a comparatively simple surgical procedure. It is doubtful

numbers such as "fifty" and "sixty", and to raise it for "four" and "forty". But these differences in intensity were inherent in the sounds of the language and meter-readings taken during normal current speech would certainly show the levels for "six" and "sixty" to be much lower than the level for "four", "five" and other vowels of that character. The speaker suggested that it would be wrong to train a speaker to say all those vowels with approximately the same intensity; the tests, especially when dealing with hearing aids, must include a proper selection of every type of vowel and consonant because when the patient wore his hearing aid he would hear normal speech. This involved differences in intensity and the hearing aid which he had must be able to cope with these differences.

Surely it was part of the explanation why it was so difficult to fit a nerve-deaf patient with a hearing aid that there was this range of intensity occurring in the speech which he had to hear, and it was very probable that the level of the high intensity components in the speech (words like "five", "nine" and "four") would be sufficient to go beyond the point at which the recruitment took place. In other words, the patient would be hearing these sounds too loudly and yet the less intense sounds would still be too faint for him to hear, therefore it did seem that what was probably needed most of all for the nerve-deaf patient was some kind of hearing aid with a very efficient automatic volume control which would level the sounds out a little.

Could any member of the Section offer any explanation of the fact that when testing with the masked speech test they came across quite a number of cases in which a man had a normal audiogram at threshold and yet was incapable of understanding speech in noise. Admittedly no equal loudness or masking tests had been carried out on these patients, and it was possible that such tests would show some abnormality in the hearing, but it was at present difficult to understand why a man with a perfectly normal audiogram should be incapable of understanding speech in noise.

Dr. DOUGLAS GUTHRIE asked if Major Fowler repeated these audiograms on successive days? Many nervous patients would give rather uncertain readings if only one record was made.

He also inquired regarding an instrument which he believed was in use in the American Air Force for speaking while the mouth and nose were covered with a respirator. Pads were applied over the larynx and the sound was transmitted to a receiver. The person using this wireless set could produce a loud voice which if adapted for deaf persons would save much vocal activity. In testing deaf people it would be very useful to be able to magnify a feeble voice.

Major FOWLER, in reply, said that he so thoroughly agreed with Colonel Formby, that he did not intend to reply to him except on one point. Audiograms should be done on all patients before they were discharged from the Forces, if the difficulty of lack of audiometers could be overcome. He did not see how these patients could be classified for compensation if audiograms were not done.

Mr. Cawthorne had spoken as though bone conduction aids could not be powered with a valve, but very efficient bone conduction hearing aids could be powered with vacuum tubes. He thought that bone conduction aids worked very well in selected cases and the instrument was inconspicuous behind the ear.

He was particularly interested in Air Commodore Dickson's statement concerning the central pathways and the loss of the hearing on the other side. He wished that he knew the answer to Air Commodore Dickson's question.

As for the ideal way of testing for air personnel he agreed with what Air Commodore Dickson had had to say on this subject, but in the case of other branches of the Services he doubted whether the procedure was worth while. For tank operators it might be well to test with a background equivalent of tank noises. He thought that people suffering from nerve deafness should not be put in artillery units, but he was not sure about people suffering from conduction deafness.

Squadron Leader Fry asked him a number of questions, but he had not endeavoured to cover the whole subject in this paper. The observations about recruitment at 5, 10, and 15 decibels above threshold were his own but similar observations had been made by Steinberg and Fletcher of the Bell Telephone Laboratory and others. Failures to obtain recruitment are usually due to a conduction deafness complicating the picture. Incidentally, he wished to draw attention to an article published by Steinberg in the *Laryngoscope* (1937, 47, 603), which bore out what he had said concerning nerve deafness and hearing aids.

He agreed thoroughly with the very lucid explanation concerning 6's and 4's. He had not intended to give the impression that there was "inadvertent" lowering of the voice with certain words. He had intended to give the impression that it was inherent in the speech; there was no question that a 4 with a deep O in it was a much louder sound in ordinary speech than 7 or 6. In speech tests of the type described it was very difficult to remember just at what level the vowel sounds should be in ordinary speech, so for test purposes they were kept at an equal level. Perhaps this testing could be done more accurately with word lists of proper type. One could go through a series of words which had one set of vowels in them, and others with another set of vowels at a different loudness, but this, of course, would make the tests more laborious.

As for automatic volume control on a hearing aid, that was, of course, one of the things needed. Even now with the amplification of a vacuum type aid, loud sounds tended to overload the instrument so that there was some control of very loud sounds and therefore protection of the patient.

In answer to Dr. Guthrie's questions, several audiograms were done at various intervals, intervals perhaps of a week or even of two. The second audiogram was, on the average, almost invariably ten decibels better than the first.

As for the laryngeal microphone, he saw no reason why what had been suggested should not be done. It might be troublesome to strap it or hold it on, but it would certainly work.

The patient was operated upon with the diagnosis of post-traumatic epilepsy and a vascular cortico-meningeal scar adherent to the dura excised. A silver clip was placed on the cortex at the site of the scar. Air was instilled subdurally and this was repeated five days later. Stereoscopic X-ray studies showed the cortex with silver clip attached, well away from the overlying dura.

#### DISCUSSION.

It is my opinion that this procedure may well be used in acute cranio-cerebral injuries. I hope to try it in certain cases which are seen twelve hours or less after injury. It is hoped to reduce the morbidity of head injuries during this war by carrying out the following procedure:

A thorough debridement will be performed with removal of potentially infected bone and damaged brain substance. The bone defect will then be repaired immediately with a plate of acrylic resin and the dura fixed to it. (Acrylic resin plates were first used in the repair of ordinary cranial defects by Dr. A. Earl Walker of Chicago (1941). Lieut. C. J. Kiffer and I have now employed them in four cases over a period of a year and a half without any evidence of reaction as far as I now know). The brain will then be kept depressed with subdural air, until healing of the damaged cortex is well in progress.

Considerable work still remains to be done to determine how long a traumatized, denuded cortex must remain away from the overlying dura to prevent the formation of significant adhesions.

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#### Recovery of Speech Following the Evacuation of Subcortical Hæmatoma—Report of Three Cases.—Major JOHN E. SCARFF, M.C., U.S. Army.

Three cases of acute subcortical hæmatoma of traumatic origin, accompanied by aphasia, are here reported. In each instance complete recovery of speech followed surgical evacuation of the blood clot.

CASE I.—C. C., male, aged 26. This soldier was found unconscious at midnight lying on the cement floor of his company latrine. There was evidence of a severe blow to the head in the left temporal region. After a few hours he recovered consciousness, but was unable to speak. This condition persisted for forty-eight hours when he was admitted to the hospital. At this time he appeared to be alert and well-orientated. There were a few abnormal pyramidal tract signs on the right side of the body, but no gross motor weakness. He had a complete motor aphasia, except for the phrase "I want a light," which he used upon all occasions and in reply to all queries. X-ray examination of the skull showed a linear fracture in the left temporal region. He ate a good lunch and a good dinner on the day of admission, but shortly after his dinner, he suddenly developed severe and continuous clonic convulsions involving primarily the right arm, but spreading to the right face and leg, and with transient spread to the other side of the body. These convulsions were of extreme violence and were accompanied by unconsciousness and incontinence. After they had persisted without remission for approximately one hour, he was taken to the operating room, anesthetized with ether, and a left temporal-parietal bone flap elevated. There was no extradural clot, but there was a thin subdural clot of blood overlying the anterior third of the temporal lobe and extending into the floor of the middle fossa. When this was removed, the underlying brain of the temporal lobe was seen to be swollen and darkly discoloured. At this point there occurred a spontaneous rupture of this discoloured cortex and a soft, semi-solid clot of blood, egg-shaped, and measuring approximately 2 in. in its maximum diameter, was extruded into the field. With it came a great amount of macerated brain tissue, leaving a large, irregular cavity lined by devitalized brain tissue, in the anterior half of the temporal lobe. Nothing further was done and closure was made without drainage.

The patient's immediate post-operative course was complicated by persistent convulsions requiring general anaesthesia to control. After forty-eight hours these ceased abruptly, and the patient then made a rapid recovery. He was out of bed on the sixth



if 50 c.c. of air could have demonstrated this lesion as well as the 5 c.c. of thorotrast used here.

### CONCLUSIONS

Thorotrast can be used to advantage in outlining cystic tumours of the cerebral hemispheres: this not only gives a clue to the pathological nature of the neoplasm but simplifies the surgical approach should operation be deemed advisable.

This contrast medium is of value in the treatment of encapsulated abscess of the brain whether it be dealt with by repeated tapping, open drainage or complete excision.

Thorotrast has the advantage over iodized poppy seed oil or air in that it mixes readily with fluid contents and may be phagocytized by the surrounding wall of an abscess so that the capsule itself will be visible in the roentgenogram within three days.

There can be little danger in the use of thorotrast from the effect of long-standing radio-activity, since the main mass of the small amount used is removed in the evacuation of the cavity. Work by Falconer, McFarlan and Russell (1943) has suggested that thorotrast may even aid encapsulation.

There will be a great increase in post-traumatic epilepsy as a result of the present war. Though I will not discuss the role played by cortico-meningeal adhesions in the development of this condition I should like to show a simple way in which they might be prevented in certain cases. For the past year and a half Dr. Ward W. Woods and I (1942) have been using air instilled subdurally for this purpose.

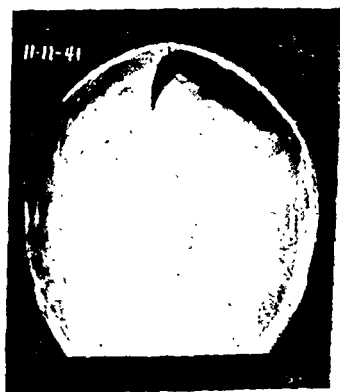
CASE VII.—A girl aged 2½ years was operated upon by me with complete removal of an encapsulated cavernous hæmangioma of the temporoparietal region. Two years later she developed Jacksonian attacks which occurred as often as thirty times a day. Encephalogram revealed dilatation of the ventricle on the side from which the tumour had been removed.

The flap was re-elevated and the dense vascular adhesions between the dura and the cortex divided allowing the cortex to fall completely away from the dura.

The following day a lumbar puncture was performed with the patient in the sitting position, a catheter having been left in the subdural space at the time of operation. Thirty cubic centimetres of cerebrospinal fluid were removed by the lumbar route and the catheter removed. X-rays now revealed considerable air between the cortex and dura, the entire hemisphere being well away from the skull. The procedure was repeated four days later, a needle being inserted through the scalp into the subdural space. Again X-ray revealed the cortex to be well away from the overlying skull.

It has been a year and a half now and the child has had no further attacks. She has had no medication during this time. Recently Dr. Woods repeated the instillation of subdural air. He reported: "X-ray studies showed depression of the cortex away from the operative site. There were a few fine lines which might be interpreted as cortico-meningeal adhesions."

CASE VIII.—A boy aged ten years entered the University Hospital November 1941 because of generalized convulsive seizures. Eight and a half years previously a debridement had been performed for a compound fracture of the frontal region.



CASE VIII.—Showing cortex with silver clip attached to site of scar, held well away from dura by air.

The patient was operated upon with the diagnosis of post-traumatic epilepsy and a vascular cortico-meningeal scar adherent to the dura excised. A silver clip was placed on the cortex at the site of the scar. Air was instilled subdurally and this was repeated five days later. Stereoscopic X-ray studies showed the cortex with silver clip attached, well away from the overlying dura.

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The patient's immediate post-operative course was complicated by persistent convulsions requiring general anaesthesia to control. After forty-eight hours these ceased abruptly, and the patient then made a rapid recovery. He was out of bed on the sixth

post-operative day. A slight, residual, right-sided weakness cleared up rapidly and there was a very early and complete return of speech. He was returned to limited duty after ten weeks.

CASE II.—P. P., male, aged 31. On October 11, 1942, this patient received a severe injury to his head in an automobile accident. Five days later he was admitted to our hospital, at which time he was in deep stupor, responding to painful stimuli with movements of the left side of the body only. He made no effort to speak. There was a slight healing wound in the right occipital region and X-rays showed a linear fracture in the left occipital region. During the next three or four days he recovered consciousness and after about ten days had completely recovered from a right hemiparesis. At this time, however, he remained completely aphasic, speaking not a single word. During the next five days he read and played cards with the men on the ward and, in fact, proved to be the best poker player of them all, despite the fact that he was unable to speak a single word.

On October 30 a left temporal flap was elevated for a presumptive diagnosis of subcortical hæmatoma of the left temporal lobe. There was no extradural clot. When the dura was opened a condition was found resembling very greatly in its position, extent and nature, the lesion described in Case I. Clot and devitalized brain tissue were irrigated away, leaving a large cavity occupying the greater part of the anterior half of the temporal lobe. The wound was then closed without drainage.

The post-operative course of this patient was most gratifying. Within two days he had begun to speak and before his return to limited duty eight weeks after his injury he was speaking Polish, Russian, German and English.

CASE III.—K. R., male, aged 23. This patient was thrown from a motor-cycle on October 28, receiving a severe cranio-cerebral injury. He was unconscious for some hours and had bleeding from the left ear. Five days later he was admitted to this hospital in a semi-comatose state from which he could be aroused by painful stimulation. At this time he showed a right hemiparesis, questionable right homonymous hemianopia and a complete "global" aphasia and apraxia. X-rays of the skull showed a linear fracture in the left temporo-parietal area. Three days later a temporal osteoplastic flap was elevated with disclosure and evacuation of a large subcortical clot from the anterior half of the left temporal lobe. The findings were again similar to those described in the first case with marked softening and devitalization of the cerebral tissue about the clot in the anterior half of the temporal lobe.

The post-operative course was smooth, although recovery from aphasia and apraxia required a little more time than had been needed in the first two cases. However, when discharged from the hospital on December 18, six weeks after his operation, he had completely recovered from his motor weakness, his aphasia and his apraxia.

Lieut.-Colonel Loyal Davis, M.C., U.S. Army, read a paper on "Experimental Studies upon Peripheral Nerve Lesions" which will appear in *Surgery, Gynecology and Obstetrics*, Chicago.

## Section of Ophthalmology

President—FRANK A. JULER, F.R.C.S.

[March 12, 1943]

**Tuberculosis of Conjunctiva.**—S. H. BROWNING, M.R.C.S., L.R.C.P. (for Mr. HAROLD RIDLEY and Mr. WILLIAMS).

A woman, aged 29. An ulcer on the lower lid was noticed in December 1942. It was a punched-out ulcer with hard edge on the inner third of left lower lid. There was a yellow patch on the bulbar conjunctiva where the ulcer touched. In the course of about one month the ulcer as such cleared up and the condition was then obviously tuberculous.

Sections of a portion of the conjunctiva showed typical tuberculous giant-cell systems and Ziehl-Neelsen's stain showed tubercle bacilli. Guinea-pig inoculation was positive and the tubercle bacilli were found to be of human type.

Sections of tissue from the lid, and of a lymph gland from the guinea-pig were also shown.

Mr. O. G. MORGAN said that he had seen three or four cases of this type in which the infection had been with the human form of tubercle bacillus. They were accidental infections and not part of a general tuberculous condition, and were treated locally with ultra-violet rays; two were sent to a sanatorium as well for six months, where they had general treatment and again ultra-violet light. All of them had enlarged pre-auricular glands, which were either aspirated or opened. In two of them he removed all the coxcomb conjunctiva very thoroughly, and he thought that they all got well. The local condition certainly cleared up, and, as far as he was aware, there was no spread to a general tuberculous infection. He felt that there was great scope for sanatorium treatment in these cases. He had also sent to the sanatorium three or four people who on account of chronic relapsing bilateral iridocyclitis had lost one eye and in whom the other eye was definitely going downhill. He regarded this condition as tuberculous, although actual tests could not prove it, and he was quite convinced that these people did very much better in a sanatorium than by being treated as out-patients.

Mr. LINDSAY REA said that he remembered a case of a young girl who had disseminated tuberculous lesions on the eyelids, face, fingers, wrists, and ankles, and through the lady almoner she was sent to Rollier's Sanatorium, Leysin, for two years. There at 5,000 feet above sea level and in brilliant sunshine she greatly improved, and she lived for 19 years afterwards. Rollier used to give intensive sunlight treatment to the everted eyelids for ten minutes every day.

In another case of a tuberculous eyelid, a boy had a gland beneath the mandible. He had considered excising the gland at the time, but he merely treated the boy for the eye condition which cleared up. The gland in the neck, however, afterwards broke down, with a running sinus for years. The patient shown by Dr. Browning had inflamed glands, which she did not like to have touched. He urged that she be sent to a sanatorium and get as much sunshine as possible.

Mr. P. MCGREGOR MOFFATT said that he had a similar case which proved to be tuberculous. It was in a boy aged 14, who was sent to Hayling Island for treatment and died

post-operative day. A slight, residual, right-sided weakness cleared up rapidly and there was a very early and complete return of speech. He was returned to limited duty after ten weeks.

CASE II.—P. P., male, aged 31. On October 11, 1942, this patient received a severe injury to his head in an automobile accident. Five days later he was admitted to our hospital, at which time he was in deep stupor, responding to painful stimuli with movements of the left side of the body only. He made no effort to speak. There was a slight healing wound in the right occipital region and X-rays showed a linear fracture in the left occipital region. During the next three or four days he recovered consciousness and after about ten days had completely recovered from a right hemiparesis. At this time, however, he remained completely aphasic, speaking not a single word. During the next five days he read and played cards with the men on the ward and, in fact, proved to be the best poker player of them all, despite the fact that he was unable to speak a single word.

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CASE III.—K. R., male, aged 25. This patient was thrown from a motor-cycle on October 28, receiving a severe cranio-cerebral injury. He was unconscious for some hours and had bleeding from the left ear. Five days later he was admitted to this hospital in a semi-comatose state from which he could be aroused by painful stimulation. At this time he showed a right hemiparesis, questionable right homonymous hemianopia and a complete "global" aphasia and apraxia. X-rays of the skull showed a linear fracture in the left temporo-parietal area. Three days later a temporal osteoplastic flap was elevated with disclosure and evacuation of a large subcortical clot from the anterior half of the left temporal lobe. The findings were again similar to those described in the first case with marked softening and devitalization of the cerebral tissue about the clot in the anterior half of the temporal lobe.

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causes no inconvenience as the affection of the eye for which the injection is given is at least as long in duration. This accident may be avoided by not inserting the needle deeper than 30 mm. and not pushing it too much inwards or outwards.

Alcohol injections are most valuable in acute or subacute primary glaucoma, for the pain of cyclitis whether associated with hypertension or not, and in glaucoma associated with intra-ocular hæmorrhage with blood staining of the cornea. In children with interstitial keratitis it not only relieves the misery of the pain and photophobia but it certainly has a beneficial effect upon the progress of the disease, since the extreme congestion of the eye is aggravated by the blepharospasm, relief of which reduces the redness of the eye and shortens the course of the disease. The injections may be repeated if necessary but the relief given lasts at least a week and often for several weeks.

Mr. O. G. MORGAN said that he gathered that the treatment described was for a condition where there was sight in the eye, and that the percentage of alcohol used was 40 to 60. The cases which he himself had treated in this way were cases of blind painful eyes, chiefly as the result of very old-standing glaucoma, but the eye looked perfectly good and one did not want to remove it. He had done four cases, and the immediate effect of the injections was rather worrying because it resulted in very great oedema, chemosis, a great deal of pain, involvement of muscles and loss of skin sensitivity. He had used absolute alcohol as was employed for the injection of the Gasserian ganglion by the neurologists. Two of these cases had done perfectly well eventually, a third after a second injection, and a fourth case was not successful and the patient refused to have another treatment.

One case was a woman, aged 46, who had had traumatic cataract needled when she was 23. He first saw her in 1938 when she had bare perception of light with poor projection and poor tension. In 1941 she ran into a post in the blackout and had a large vitreous hæmorrhage. She had very great pain afterwards which continued for about nine months. The question arose as to whether he should remove the eye or try alcohol injections. He first injected novocain, and then  $1\frac{1}{2}$  c.c. of absolute alcohol as near as he could get to the ciliary ganglion. For the next forty-eight hours she had extreme pain, great chemosis and swelling over the eyelid. This continued until the third day, with anæsthesia down the side of the nose and in the face. She had almost no movements of the eye. There was paresis of the extra-ocular muscles, and the only movement that remained was a very slight one in the external rectus. The condition gradually became less acute and when he saw her again she could move her eye up and down, but there was no adduction; the anæsthesia of the face had completely disappeared. Two months later she came up again with no pain at all, and the eye, which had been divergent, was now only slightly so. She had full movements except that adduction was slightly restricted. She had no anæsthesia at all in the face, and it seemed that she was likely to keep the eye.

A second case was very much like the first, and also had the paresis and anæsthesia of the skin. Of the four cases three were ultimately successful, but one was as bad as ever and the eye in that case had to be removed.

He felt that it was probably unnecessary to use such strong alcohol and that 60% would be sufficient.

Mr. A. J. B. GOLDSMITH said that he could recall serious trouble in only one case. This was in an old lady of 84 with an absolutely glaucomatous eye. He used 80% alcohol. She had oedema of the lids and a good deal of chemosis. The pain was relieved after the first few days, but then recurred and the eye had to be excised. Behind the eye there was a collection of pus: a swab of this was sterile. Probably the stronger solution of alcohol had caused a fat necrosis with secondary sterile abscess formation. That was the only case in which he had had any trouble; all the other cases had been extremely satisfactory.

Mr. LINDSAY REA said that in the case of an old lady of 84 he would use retrobulbar injection of novocain with a curved needle and remove the eye. This could be done without any pain or shock. Although he would remove the eye in an elderly person, he thought that in other cases there must be a very great opening for this use of alcohol. The nerve cases seen at hospital were usually treated with absolute alcohol, but the oedema made one a little bit frightened.

Lieut.-Colonel DERRICK VAIL (U.S.A.M.C.) said that in the States a few ophthalmologists had practised this method since 1930. From his experience attending meetings of the Royal Society of Medicine he felt convinced that British ophthalmologists were not as conservative as their American colleagues, nor as conservative as Americans had expected to find them. From his personal experience of this method, it was the only one which worked in a patient with bilateral acute glaucoma, aged 65, who was a diabetic and had a high degree of vascular hypertension. By means of alcohol injection, she was tidied over the acute stage of the pain, but before surgery could be undertaken she had died.

Dr. EDWARD F. WILSON pleaded that in cases of the hæmorrhagic type of glaucoma the operation of cyclodiathermy should be tried. He had carried this out in one case and the relief from tension and pain was immediate. He knew that it had been tried in America.

very well indeed. After six months he came back and was practically normal. Concerning the transmission of the condition from one tuberculous subject to another, he saw an interesting case seven or eight years ago in which a girl had what was clinically a primary chancre of the lip, which was subsequently proved to be tuberculous, and it was then found that her fiancé was suffering from open tuberculosis of the lungs.

THE PRESIDENT said that he had seen several cases of primary tuberculosis of the conjunctiva which did well with local treatment. In one case a sub-epithelial roll in the fornix was dissected out. Cases with ulceration were scraped and on the whole did well. Personally he was afraid of large doses of tuberculin. In a modern textbook it was recommended that the initial dose should be 1/10,000,000 mg. Whether that had any effect he could not say but it was very different from giving 1/10,000 mg.

Mr. HAROLD RIDLEY said that there was no sign of tubercle elsewhere in his patient. The case was seen by one of his colleagues, who suggested that the infection had been caught from farm animals. Whether it was a true case of Parinaud he could not say.

**Familial Corneal Dystrophy.**—V. B. PURVIS, M.B. (for Mr. N. FLEMING and Mr. DORNE).

**Choroidal Sclerosis.**—V. B. PURVIS, M.B. (For Mr. LAW).

## The Control of Ocular Pain

By CHARLES B. GOULDEN, O.B.E., F.R.C.S.

THERE is considerable difficulty in controlling the pain produced by glaucoma, iritis, and cyclitis. The pain is frequently prolonged and if controlled by the administration of drugs, means their frequent administration, which, if morphia is used, is undesirable and carries the risk of initiating a deplorable habit.

Pain from superficial lesions, such as abrasions of the cornea, can usually be controlled by the use of a local anæsthetic and a pad and bandage. The pain of iritis may be reduced by the subconjunctival injection of air as introduced by Magitot in 1912. The air must be injected liberally by a syringe and fine needle above, below, to the right, and left so as to cause a large area of emphysema. But the effects of the procedure have a short duration and other means of alleviating pain had to be found.

Two methods are available: (1) Anæsthetization of the sphenopalatine ganglion. (2) The injection of alcohol into the orbit.

(1) *Anæsthesia of the sphenopalatine ganglion.*—This is produced by the injection of novocain into the posterior palatine canal with a needle 30 mm. long. The effect of the injection is immediate but the action is not very prolonged and it is not safe to substitute alcohol for novocain. Blepharospasm disappears, the eyes open, photophobia goes and there is no more pain.

(2) *Intra-orbital injections of alcohol.*—In 1930 Weekers of Liège drew attention to the sedative action of intra-orbital injections of alcohol. There is no difficulty in carrying out the injection, and there is no danger, provided that it is carefully carried out. There is needed a 2 c.c. syringe and a needle 40 mm. long, some 4% solution of novocain, and 40 to 60% ethyl alcohol. The needle used must be fine, with a short point which must not be too sharp so as to avoid injury to the optic nerve or orbital veins. It is inserted 6 mm. below the middle of the external palpebral ligament through the skin of the lower lid and the point directed towards the sphenoidal fissure through the muscle cone. It must not be inserted more than 30 mm. so that the point may not reach the sphenoidal fissure which is 10 mm. deeper. The piston of the syringe should be slightly withdrawn to make certain that a vein has not been pierced. One c.c. of a 4% solution of novocain is injected and this will become diffused around the ciliary ganglion in exactly the same way as when giving a retro-ocular injection of novocain before operating upon an eye. The needle is left in place and in five minutes 1.5 c.c. of ethyl alcohol 40 to 60% are injected. This does not cause pain and its sedative effect is almost immediate. One effect of using too deep an injection, and thus reaching the sphenoidal fissure, is paralysis of one or more extra-ocular muscles. The external rectus is the one usually affected, but the action of the muscle returns completely by at most six weeks and the paralysis

## Section of Physical Medicine

President—P. BAUWENS, M.R.C.S., L.R.C.P.

[April 14, 1943]

### The Measurement of Non-Ionizing Radiations for Medical Purposes

By W. V. MAYNEORD and T. J. TULLEY

(Physics Department, Royal Cancer Hospital (Free), London)

*Introduction.*—During the course of recent work on the energy absorbed by a patient undergoing treatment in a beam of X or gamma rays interest was aroused in the corresponding problem for other types of radiation. A search of the clinical literature revealed how rarely any measurement of radiation is recorded for infra-red, visible or ultra-violet light, and preliminary experiments were therefore made to obtain data in absolute energy units. We shall in the first instance restrict our attention almost exclusively to visible and infra-red radiations as presenting a simpler problem than ultra-violet light.

No apology is needed for insistence on the importance of measurement of radiation. The correlation of data obtained by different workers, the safety of the patients and the avoidance of accidental over or under exposure, the study of the physiological effects of the same quantity of energy at different parts of the wavelength scale, the interpretation of clinical and biological results, all demand precise quantitative data. Moreover, the change which comes over the aspect of a subject as it becomes quantitative is profound and progressive. The making of measurements not only supplies valuable information but leads to a change of outlook which in time profoundly affects the whole subject.

*Methods of measurement of infra-red radiation.*—The discovery of infra-red radiation was made by Sir William Herschel in 1800 by inserting thermometers of "exquisite sensibility" in different parts of the solar spectrum, and the method of choice of measurement of infra-red is still to observe the small rise of temperature of an absorber when exposed to the beam. The absorber should seize all energy falling upon it, showing no selective absorptions or reflections and so be independent of the wavelength of the incident radiation. We cannot here discuss the merits of or objections to the various means which have been employed to measure infra-red and visible rays such as the differential thermometer, the thermocouple or thermopile, the micro-radiometer, the bolometer, the pyroheliometer, the flow calorimeter, superconducting films, or even photo-electric cells. We may simply point out that for therapeutic purposes the total amount of radiation to be measured is usually quite large and that therefore the devices of the physical laboratory to obtain extremely high sensitivity are not required. Stability and simplicity coupled with reasonable accuracy are of more importance than sensitivity in instruments designed for clinical use, though in experimental work it is desirable to have considerable reserves of sensitivity available.

We have used in our measurements either a Cambridge Moll type microthermopile or General Electric vacuum thermocouples with appropriate electrical instruments.

#### CHOICE OF CLINICALLY SIGNIFICANT QUANTITY

(A) *Amount of radiation.*—One of the most difficult questions involved in this work is the choice of quantity of greatest clinical significance and it is partially to obtain the views of those using non-ionizing radiations that these preliminary results are set out. We felt it also important to try to obtain uniformity of nomenclature among different workers.

The quantity which stands out as obviously suitable for measurement is intensity of radiation. This term "intensity of radiation" should, we suggest, be retained and used in its exact physical sense, namely the amount of energy flowing in one second through one square centimetre perpendicular to the beam. The absolute unit of intensity, namely ergs per cm.<sup>2</sup> per second, would be the natural one in which to express infra-red and visible intensities for therapeutic use but in practice this unit would be too small and we have found more convenient the derived practical unit, namely, one gramme calorie per square centimetre per minute. This unit has the additional advantage of involving the thermal properties of water which are similar to those of soft tissues, and of being in general use when considering the gain and loss of heat by the body, and in measuring solar radiation. It is the equivalent of  $6.96 \times 10^5$  ergs/cm.<sup>2</sup> sec., and will be referred to as "one g.c.m.".

If the intensity of the radiation be known, together with the area of the field, then by multiplication we find the amount of energy falling on the body per minute, and



Mr. GEORGE BLACK said that he thought there might be a place for this method in the treatment of Mooren's ulcer. These were cases which in the final stages of the disease caused a great deal of pain and treatment had to be palliative. In one case—not his own—a surgical colleague was struck by the fact that he obtained much more from his treatment than he had hoped for. This case had little or no perception of light, but following the treatment the ulcer of the cornea healed and vision was materially improved. This applied to a case of his own as well as to that of his colleague.

Personally he was rather dubious about the large scale use of alcohol in the treatment of painful eye conditions. It must have a destructive effect and an extreme degree of destruction had in fact been shown in some cases. In other cases, though the degree of destruction was minor, considerable anatomical disorganization might be caused with possible trophic changes in the cornea or other tissues of the eye. He felt, however, that in suitable cases the treatment in some way broke down a vicious circle. These were congested eyes, with brawny oedema at the margin of the cornea, and a notable consequence of alcohol injection was the rapidly increasing pallor. It seemed to him that a vicious circle associated with hypervascularity was broken by the injection of the alcohol, and subsidence of the vascularity led to brightening of the cornea and healing.

Mr. R. E. BICKERTON said that in the old days in Vienna the treatment of Mooren's ulcer was by extirpation of the lacrimal sac and was invariably effective.

Lieut.-Colonel TOVELL (U.S.A.M.C.) said that he was not an ophthalmologist but an anæsthetist. He had had some experience with the injection of alcohol, more particularly in the injection of the sciatic nerve for the treatment of sciatica. If it was desired to retain motor function not more than 40% of alcohol should ever be used.

He had used pontocaine in the usual concentrations. Pontocaine being ten times as potent and, therefore, ten times as toxic as novocain, one should be absolutely sure that the absorption was not too rapid, otherwise convulsions might occur. The treatment of convulsions was by means of oxygen under intermittent pressure. If the convulsion was of such intensity that one got spasm of the diaphragm then one could not get in oxygen under pressure and there should be preliminary treatment with pentothal in these circumstances, in order to relax the spasm.

Mr. C. B. GOULDEN, in reply, said that he had expected that the question of possible injury to the optic nerve would be raised. He did not think that such a mischance had been reported. He had been using this method since 1937. He had learned it from Magitot (*Ann. Oculist., Paris* (1937) 174, 361) in Paris, who had published a paper giving his experiences; he had then been using the method for four years. Its chief value was in cases of acute glaucoma. It could be done even in the out-patient department before admitting the patient into the ward for surgical procedure. If it was necessary to remove the eye the use of alcohol was of value because the patient, as had been said, was tided over the few days before excision took place, and he was made free of pain at once. It was a most useful method for overcoming pain in interstitial keratitis. It certainly shortened the length of the attack, due probably to the blepharospasm having been overcome.

Since, however, the determination of the energy distribution in the spectrum of a given source requires considerable experience and experimental equipment and its surface temperature is not usually readily measurable it might be worth while to try to obtain some measure of the "quality" of a beam by studying its absorption in some standard material. We have therefore carried out experiments along these lines.

Care must be exercised in the interpretation of such results owing to the importance of scattered radiation. If a narrow beam be employed and the filters be placed at some distance from the detector little scattered radiation is included in the measurement, but if wide beams and absorbers near the detector be used a great deal of scattered radiation is collected and the transmission appears much greater.

Two sets of results are given (figs. 1 and 2), only one of which includes appreciable scattered radiation. The difference in apparent transmission from the high temperature sources is marked.

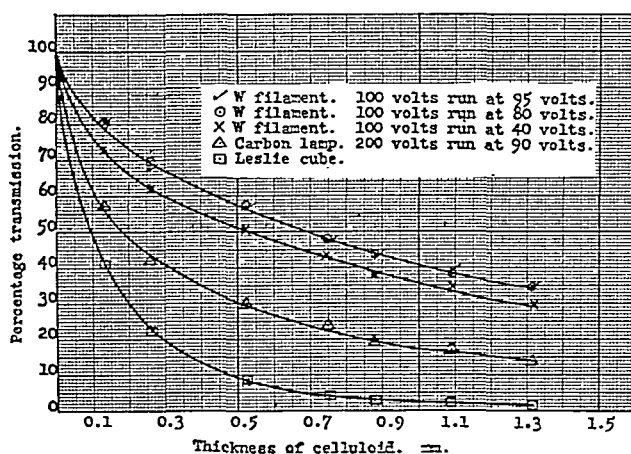


FIG. 1.—Absorption in celluloid of radiation from various sources.

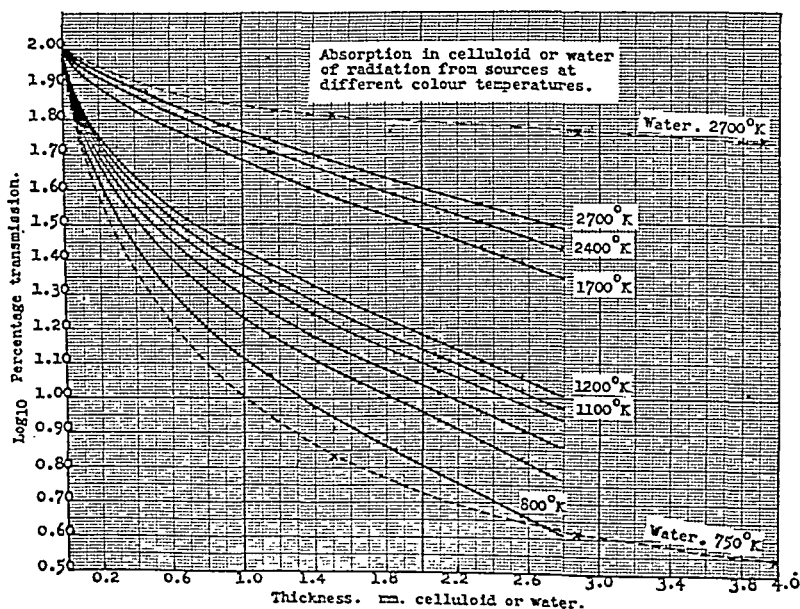


FIG. 2.—Absorption in celluloid and water of radiation from various sources.

obviously knowing the time of exposure may calculate the total energy reaching the skin. Owing to the surface reflections and emerging scattered radiation this is not a measure of the energy absorbed by the patient. These reflections whether diffuse or specular vary in a complex way with the wavelength of the radiation throughout the visible and infra-red regions (Schultze, 1930; Pearson and Gair, 1931; Bode, 1934) and separate investigations are therefore necessary to deduce the energy absorption from the incident energy. Much further information on this subject is required. We think it not impossible, for example, that the degree of polarization of the incident radiation may affect the results.

To one accustomed to working with X or gamma radiation the physical quantity of greatest biological significance might appear to be the energy absorbed per unit mass of tissue ("dose") at any depth, but it is doubtful whether this is the important quantity in the infra-red where heat sensation as well as other physiological effects are concerned. Although there is considerable literature on the penetration of infra-red into soft tissues (Bachem and Reed, 1929, 1931; Cartwright, 1930) the precise distribution of energy throughout the tissues is little understood and very difficult to investigate. We suggest that the word "dose" be reserved for energy absorbed per unit mass to conform with the practice in other fields.

If we imagine a very intense beam of radiation applied for a very short time the rise of temperature occurring initially in any small volume of tissue at any depth will presumably be proportional to the energy absorbed in that volume. Owing to the complex physiological response of the organism as well as the conductivity of the tissues there will be no simple relationship between the temperature, after even a short period, and the energy originally absorbed.

It will easily be seen that in a beam of moderate intensity applied for some time the equilibrium conditions will be hard to predict, but in general the greater the penetration of the beam the greater the depth at which a temperature maximum may be expected. The results of Sonne (1926) show precisely this effect, the relatively penetrating near infra-red producing a maximum temperature at a depth of 5 mm, while the outer infra-red produces its maximum very near the surface.

In view of these considerations the measurement of incident energy during treatment is evidently the first step to be taken, leaving the more elaborate physical investigations to be made while valuable clinical data are being accumulated.

(B) "*Quality*" of radiation.—Another matter of practical interest is the average wavelength or "*quality*" of the beam of infra-red radiation employed. To the physicist the only satisfactory specification of an infra-red source would be the complete energy distribution throughout its spectrum. Even this would not be quite satisfactory as small absorptions of certain wavelengths take place as the rays pass through the air to the patient. Again, far too little information is available in spite of such pioneer investigations as those of Coblentz and his co-workers (1939). We are at the moment constructing a rock salt spectrometer for detailed investigations of energy distributions. It is known that the same intensity of radiation in different wavelength regions of the infra-red produces different heat sensations (Sonne, 1926; Hartley, 1934) and all the evidence available suggests that here is a question of penetration of the radiation in the tissues. Long wave infra-red beyond about  $1.5\mu$  is strongly absorbed in superficial layers of the skin whereas radiations of average wavelength of  $1\mu$  are relatively penetrating as shown by the work of Sonne (1926), Cartwright (1930), Forsythe (Forsythe and Christison, 1930), and others (Laurens and Foster, 1937; Oppel and Hardy, 1937). It is nevertheless remarkable how frequently one finds in the literature erroneous statements as to the relative penetration by different wavelength regions. So far as we can judge all the available evidence indicates that the short wave infra-red radiation immediately adjoining the visible spectrum is the most penetrating, so that very high temperature sources are required if penetration be desired.

This follows from Wien's Law which states that the wavelength of maximum energy in the spectrum is inversely proportional to the absolute temperature of the source if the latter be a "black body", though the law is roughly true for most sources. Thus the higher the temperature of the body the shorter the wavelength of the maximum radiation. For  $6,000^\circ\text{K}$ , the approximate temperature of the surface of the sun, the maximum energy is observed in the visible at about  $4,800\text{ \AA}$ . For  $2,880^\circ\text{K}$ , a common temperature for the tungsten filament of an electric lamp, the maximum occurs in the near infra-red at  $10,000\text{ \AA}$  ( $1\mu$ ), while for  $300^\circ\text{K}$ , approximately room temperature, it occurs in the far infra-red at  $96,000\text{ \AA}$  ( $9.6\mu$ ).

The energy distribution in the spectrum of a "black body" is in fact completely defined by its surface temperature and even for therapeutic sources a fair idea of the quality of radiation emitted may be gained from a statement of that temperature.

encountered in therapeutic practice were obtained at distances not less than 25 cm. No systematic deviation appeared and no deviation from linearity greater than  $\pm 2\%$  was observed over a range of intensities from 0.003 up to 6.5 gm.cal./cm.<sup>2</sup> min. In all these experiments great care was necessary to maintain constancy of the supply voltage to the lamp.

Having carried out this series of measurements with the Moll we knew the intensities of radiation at various distances from the 3 kW. lamp and used these known intensities

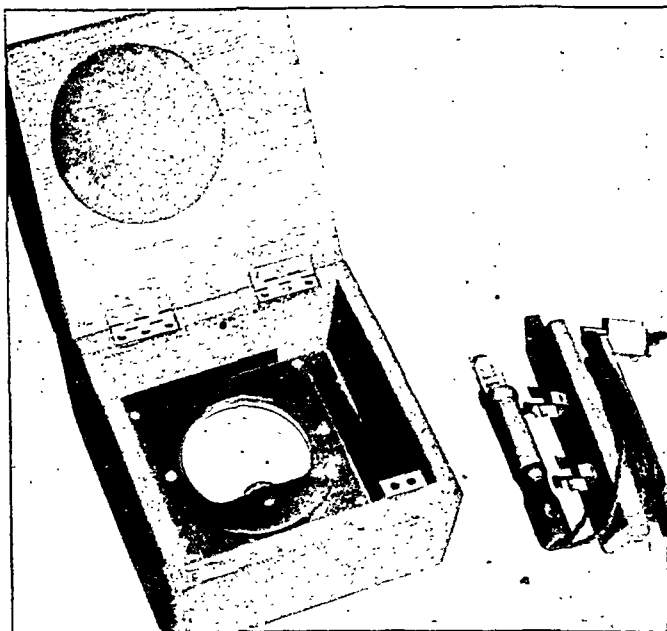


FIG. 3.—Clinical instrument. (The plug attached to the vacuum thermocouple is inserted at the side of the micro-ammeter.)

to calibrate the clinical measuring unit. The results of the calibration are shown in fig. 4.

It will frequently happen in practice that radiation will not fall normally on the skin so that the flow of energy per unit area across the surface will be reduced approximately in proportion to the cosine of the angle of incidence. The question naturally arises whether the measuring instrument will record correctly the normal intensity corresponding to these other angles of incidence, that is itself obey the cosine law. We have investigated this point and the results of the comparison are demonstrated in fig. 5. The difference between front and back sensitivity arises from the fact that the back is not blackened. We later make use of this difference in sensitivity in an attempt to estimate reflection from the skin.

Probably the most important objection to the thermocouples in their present form arises from the absorption of long wave infra-red in the glass envelope. The transmission of glass is normally high up to about  $2.5 \mu$ , falling off gradually until beyond  $3.5 \mu$  little is transmitted. For the radiation from high temperature sources such as tungsten filaments at approximately 2,800° K in glass envelopes this absorption is of little importance, but for low temperature sources such as open heaters, either just "visible" or "non-visible", a large fraction of the energy lies in the region absorbed by the glass and the instruments are correspondingly less sensitive. In addition the gradual heating of the glass causes troublesome drifts of zero.

Clearly it is desirable to have eventually a clinical measuring instrument free from such wavelength dependence. We had hoped to obtain thermocouples with rock salt or other windows but so far have not succeeded, and it is therefore necessary that the thermocouples at present in use be restricted to the measurement of high temperature radiation unless specifically calibrated for the type of emitter used. This is a matter

We have used throughout Ilford X-ray film cleaned of gelatine but have as yet no experience of the differences which may exist between samples. The absorption by celluloid clearly does depend upon the temperature of the source and might be a useful criterion of quality.

The effects of filtration by water on the radiation from high and low temperature sources are shown in fig. 2. Again it will be seen that the low temperature radiation is very heavily absorbed.

#### CALIBRATION

*Absolute standardization.*—In this paper we do not wish to discuss at too great length the purely physical investigations into the methods of measurement employed, but will state broadly some of the results of detailed study.

Our results depend ultimately upon the calibration by the National Physical Laboratory, in absolute units, of the Moll microthermopile with fluorite window. The result of this calibration is expressed in the statement that 1 milliwatt of radiant energy per square centimetre produces an e.m.f. of 61.5 microvolts. The thermopile was used in conjunction with a low resistance (8.4 ohms) Cambridge d'Arsonval galvanometer. Initially a direct deflection method was employed but abandoned in favour of the compensating circuit used by Guild (1930) which gives a much greater range and precision. The voltage was measured with an N.P.L. calibrated Ferranti voltmeter and was divided by resistances of high precision. To check possible changes in the thermopile we were anxious to have available a standard of radiation. As it was not possible to obtain such a standard in this country we applied to the Bureau of Standards, Washington, asking whether such standards were available there. The Director very kindly presented us with a 40 watt carbon filament lamp whose radiation under specified conditions is accurately known. These conditions have been carefully reproduced by us, the power input being measured with substandard calibrated Cambridge instruments. Again, we do not wish here to discuss the results in detail but, suffice it, the observed thermopile e.m.f. agrees with that expected from the two calibrations to within 2%. A comparison of the N.P.L. and N.B.S. scales of radiation was described by Guild in 1937 when it was concluded that the scales agree very closely, certainly to within 2 or 3 parts in a thousand, though inconsistencies of about 1% were observed between different lamps. In view of the many difficulties involved our agreement can be regarded as satisfactory, and it is clear that we have a calibration in absolute units amply precise for clinical purposes.

*Relative measurements.*—The Moll thermopile, although suitable as a standard instrument, is not convenient for measurement in therapeutic practice and in any case we naturally do not wish to expose our standard instrument to the rough and tumble of clinical use. However we were fortunate again in having presented to us a number of vacuum thermocouples of the type manufactured by General Electric (Schenectady) and described in the General Electric Review (Stack, 1939; Gen. Elect. Rev., 1941). These vacuum thermocouples are intended for furnace control. Enclosed in a vacuum the thermocouple consists of a very thin strip of two different metals blackened on one side. Radiant energy of therapeutic intensities falling upon the thermocouple produces easily measurable e.m.f.'s. For example it was soon found that moderate sunshine gave currents of the order of 80 micro-amps. in a robust commercial micro-ammeter of internal resistance 71.5 ohms (Ferranti). The thermocouples are quick acting, a steady reading being obtained in five or six seconds.

For clinical use a thermocouple of this type has been mounted as shown in fig. 3, coupled with such a micro-ammeter. This instrument reads up to 250 micro-amperes and has been calibrated as below to read directly in gm.cal./cm.<sup>2</sup> min. Readings are rarely required above 150  $\mu$ a and an instrument of somewhat higher sensitivity would be an advantage. The whole apparatus is, however, robust, quick acting, very suitable for clinical observations, and may be safely entrusted to semi-skilled personnel.

*Investigation of the characteristics of the measuring instruments.*—In view of the fact that the Moll thermopile was calibrated at relatively low intensities and that it was to be used at high intensities of radiation it was necessary to investigate the relationship between its e.m.f. and the incident intensity, that is study any possible deviations from linearity of response.

This was carried out by making use of the inverse square law down to intensities at which the calibration was reliable. Initially a 40 watt lamp was used as source but it was not possible owing to its finite size to attain sufficient intensity at distances for which the inverse square law could be safely applied. We therefore obtained a 3 kW. clear gas-filled tungsten filament lamp (Osram studio lamp) with grid filament giving a very concentrated source. With such a source intensities beyond those ever likely to be

clinical sources are of the same order but generally greater than that of strong sunlight. Not enough data have yet been obtained to say anything about the variations of sensitivity of different parts of the body or with pathological conditions. Indeed it is partly the aim of this paper to persuade clinicians carrying out large numbers of infra-red treatments to collaborate in the collection of such data.

For comparison we may mention that we find an intensity of the order of  $2 \text{ gm.cal./cm.}^2 \text{ min.}$  is about the maximum for comfort (with the high temperature source) while the threshold for pain appears to be at about 3 to 4  $\text{gm.cal./cm.}^2 \text{ min.}$  in agreement with Hartley (1934) who found a value of 3.7 for a similar source. Sonne (1926) found that the maximum amounts of visible, "inner" and "outer" infra-red which could be borne by human skin were in the ratios of 3.11 to 1.79 to 1.33  $\text{gm.cal./cm.}^2 \text{ min.}$ , values which may be correlated with the differences in penetration by the radiations.

We may now discuss three further investigations illustrating the usefulness of measurements in practice and the kind of problem to which they may be applied.

It is clear that there is a variation of intensity of radiation over the patient's skin and we have therefore carried out a series of measurements with an Osram 500 watt gas-filled pearl glass daylight blue lamp in a reflector, to investigate the kind of variations which may occur with a normal type of therapeutic source.

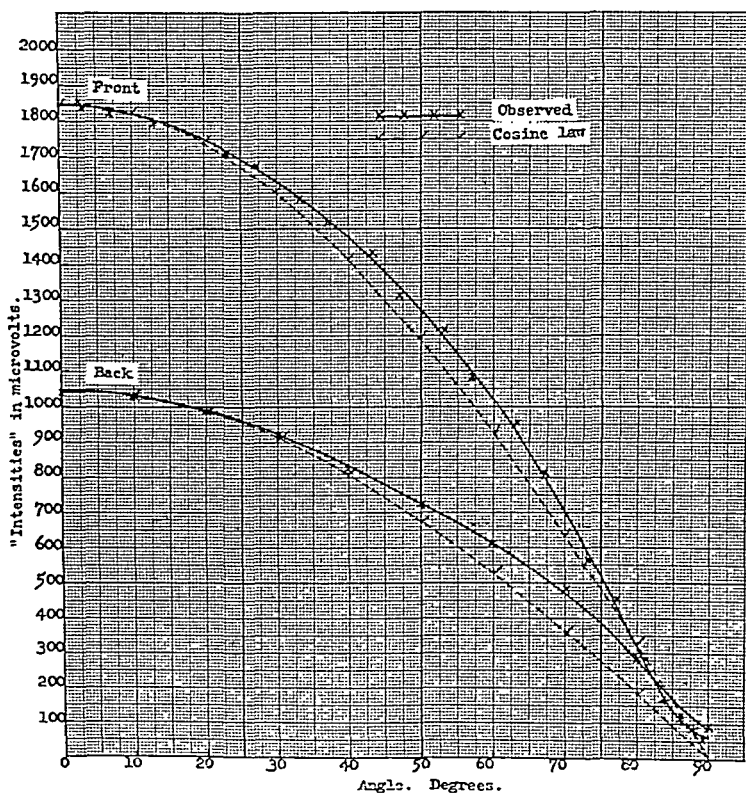


FIG. 5.—Cosine law investigations.

The top of a low wooden table was marked out in 5 cm. squares so as to provide a suitable co-ordinate system. The measurements were made with the thermocouple always parallel to the table top, that is normal intensities were measured. The results may be seen in fig. 6, which show iso-intensity curves for three conditions. In position 1 the lamp is drawn as far as possible into the holder. In position 2 it was moved 2 cm. outwards, and in position 3 it was moved 3 cm. further, that is 5 cm. out in all. These positions of course correspond to different focusing of the radiation. The distance from the rim of the reflector to plane of measurement was in all cases 1 metre. No attempt was made to secure symmetry as it was desired to reproduce the kind of conditions

of importance in practice as the glass envelope eliminates long wave infra-red, a relatively small quantity of which produces a vigorous heat sensation. We have made comparison measurements between the sensitivities of the Moll and the General Electric thermocouples for sources at different temperatures. If the sensitivity of the G.E. couple be taken as 1.0 for high temperature glass-filtered radiation it decreases to approximately 0.5 for a source at dull red heat.

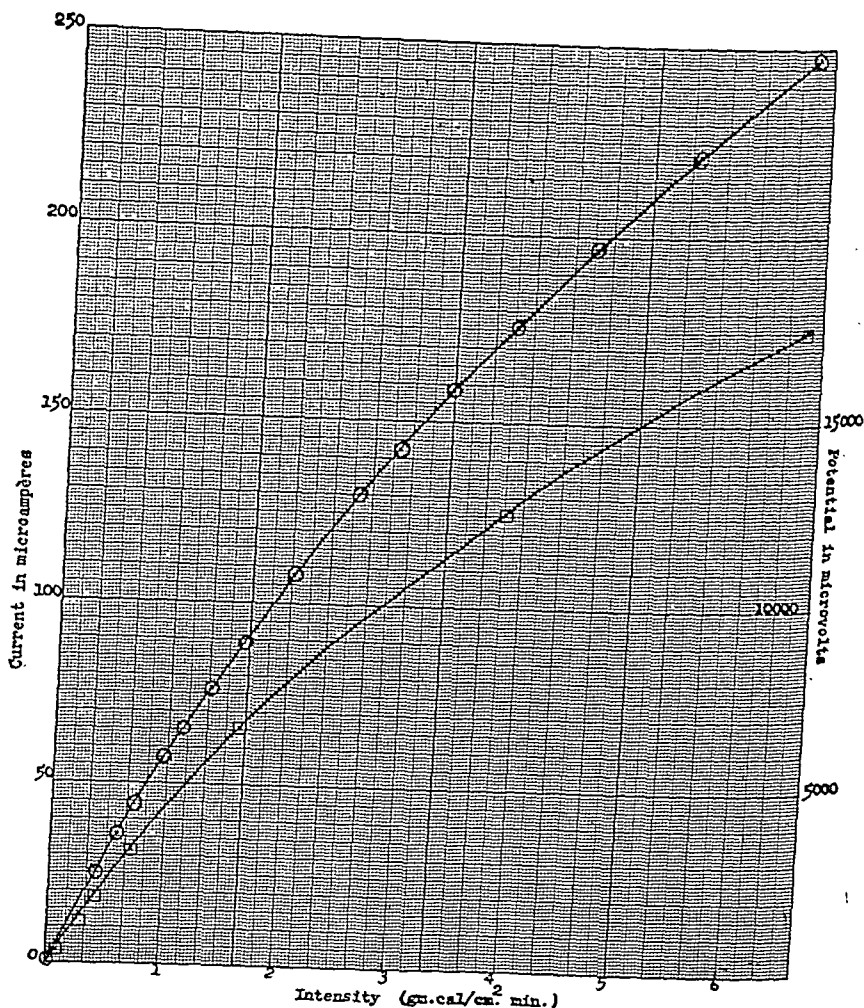


FIG. 4.—Calibration of clinical instrument.

#### APPLICATIONS TO CLINICAL PROBLEMS

The first question we have attempted to answer has been "What are the absolute intensities likely to be encountered in clinical practice?"

During the course of the last few months measurements have been made on about twenty-five patients undergoing treatment with high temperature sources, viz. 500 and 1,000 watt tungsten filament lamps in reflectors. Intensities observed at the centres of treatment fields accepted as "comfortable" by the patients were found to vary from 0.6 to 3.6, most of the values being in the neighbourhood of 2.0 gm.cal./cm.<sup>2</sup> min. On different days, however, the "comfortable" intensities for the same patient were very different, varying in one case from 1.5 to 2.6 and in another from 2.0 to 3.6 g.c.m. It is interesting to remember that the intensity of strong sunlight on a midsummer's day is of the order of 1 to 1.5 gm.cal./cm.<sup>2</sup> min. We arrive therefore at the conclusion, which might have been expected, that the absolute intensities of the radiation from

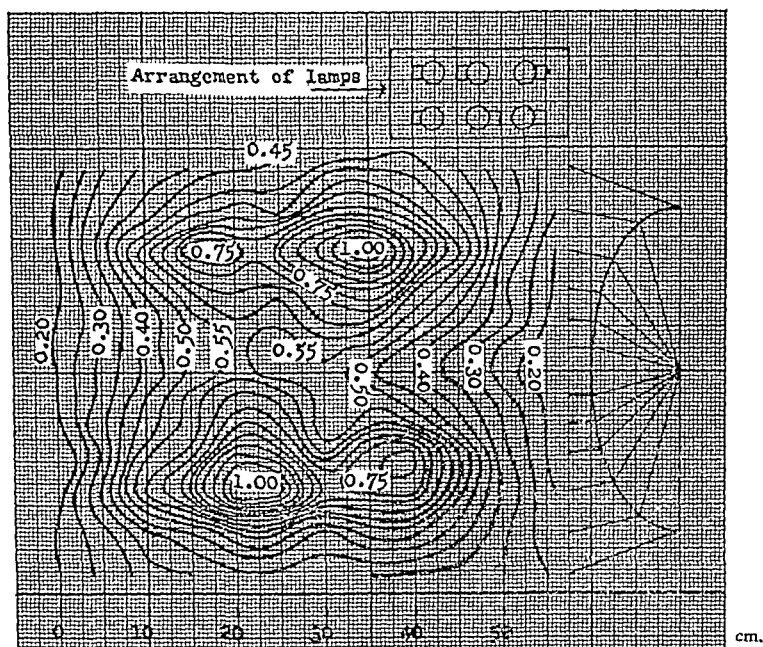


FIG. 7.—Variation of intensity in small Ministry of Home Security cradle, over an elliptic cylinder of the section shown. (Chromium plate interior.) (Gm. cal/cm.<sup>2</sup>. min.)

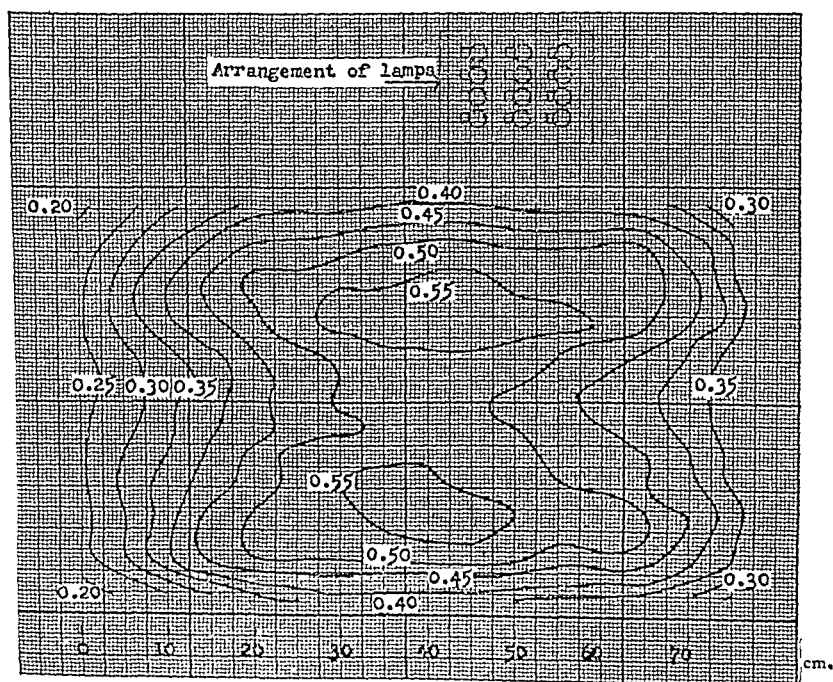


FIG. 8.—Variation of intensity in large Ministry of Home Security cradle, over an elliptic cylinder. ("Aluminium paint" matt interior.) (Gm. cal/cm.<sup>2</sup>. min.)



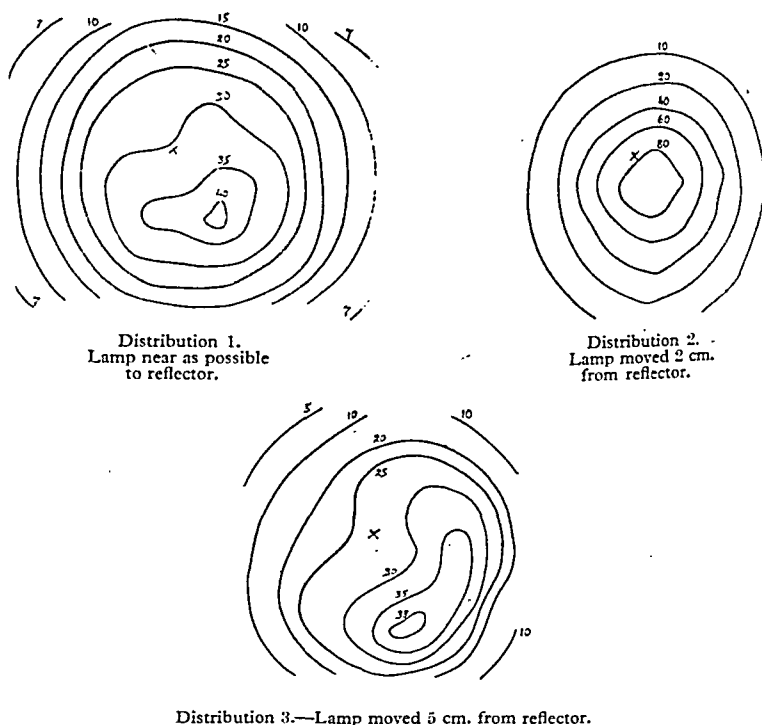


FIG. 6.—Distribution of radiation over a plane surface perpendicular to the axis of the beam.

met with in practice. A cross marks on each diagram the point on the axis of the reflector. It will be seen that in position 1 the intensities vary from 40 down to 10 arbitrary units, in position 2 from 80 down to 10, and in position 3 from 38 down to 10. These measurements were made prior to calibration. Subsequently it was found that 10 arbitrary units equal 0.17 g.c.m.; 38 arbitrary units equal 0.67 g.c.m.; 40 arbitrary units equal 0.71 g.c.m.; 90 arbitrary units equal 1.75 g.c.m. We see immediately how very heterogeneous the field can be and how, if we wish to obtain a uniform distribution of radiation, other types of source must be devised.

The next study of distribution of radiation arose from a recent paper by Brown, Evans and Mendelssohn (1943) on the action of radiant-heat cradles in which it was reported that burns had occurred. Blackening of the reflector makes a greater heat input tolerable, an effect ascribed to the conversion of supposedly harmful short to long wave radiation. This explanation appeared to us unlikely in view of the experimental evidence already adduced and we therefore undertook measurements of the radiation inside cradles of standard Ministry of Home Security design.

The patient was represented by a cylinder of elliptic cross section semi-axes 18 and 10 cm., measurements being made over the whole of its upper surface. Iso-intensity curves in a polished cradle smaller than that used by the workers quoted show the existence of "hot spots" (fig. 7). Measurements were also made with a cradle of standard dimensions having a diffusely reflecting internal surface. It was found that the distribution of radiation is much more even (fig. 8), the high spots being much less marked. It seems not impossible that the burns were caused by local concentrations of energy on the skin.

A third distribution problem was also investigated. It is well known that from point sources of radiation the intensity falls off inversely as the square of the distance, and not infrequently one may find the same law applied to a source with a reflector. It is clear on purely physical grounds that no such rule can hold, but we thought it of interest to find the actual variation with distance in a few cases. Fig. 9 shows the intensity of radiation in arbitrary units along the axis of a beam from a lamp (Osram 500 watt) without a reflector, and in its reflector in the three positions previously described. It will be immediately obvious that the inverse square law does not apply and indeed

of energy involved in treatment with very different kinds of electromagnetic radiations (Mayneord, 1942). Typical results are tabulated below.

Type of radiation	Representative intensity ergs/cm. <sup>2</sup> sec.	Total energy absorbed
High voltage X-rays. (200 kV. heavy filter) ... ..	$2 \times 10^3$	60 gm. cal. in six weeks
Ultra-violet light ... ..	$2 \times 10^2$	8 gm. cal. at one sitting
Infra-red ... ..	$7 \times 10^5$	24,000 gm. cal. at one sitting

For comparison it has been assumed that 20% of the incident radiation is reflected in the infra-red, but even then the very large amount of energy absorbed is sufficiently obvious.

It may also be of interest to analyse from this point of view in a little more detail the records of a sample patient. In collaboration with Dr. Flood a preliminary treatment card upon which the observations may be recorded was drawn up, and part of which is reproduced.

TREATMENT CARD

Date	Fields	Field size (cm. diam.)	Incident intensity		Detector facing skin		Time in mins.	Gm. cal. abs'd.	Skin temp.		Skin temp.		Notes
			Mid.	Edge	Mid.	Edge			Initial		Final		
1943	Lumbar												
7/1/		25	1.6	1.2	1.2	1.0	20	11,000	34	97.0	38	98.4	
11/1/		25	2.0	1.6	1.4	1.2	20	14,100	33	97.0	37	98.7	
12/1/		25	2.6	2.4	1.6	1.4	20	19,600	34	96.2	38	97.8	
14/1/		25	2.0	1.8	1.1	1.3	20	14,900	33	97.0	38	98.0	
15/1/		25	2.3	2.0	1.4	1.3	20	16,900	33	97.0	38	98.4	
18/1/		25	1.8	1.2	1.0	0.8	20	11,800	34	96.8	37	98.2	
20/2/		25	2.5	2.0	1.4	1.6	20	17,700	33	97.0	38	97.8	
25/2/		25	2.6	1.8	1.5	1.2	10	8,600	32	97.0	34	97.8	
1/3/		25	1.5	1.4	1.3	1.2	15	8,600	33	97.4	39	98.4	
2/3/		25	2.4	2.2	1.4	1.3	20	18,100	34	97.4	37	98.4	

The physical factors recorded include "incident intensity". This quantity was measured by placing the thermocouple, backed by a black velvet covered wooden disc of 4 in. diameter, on the skin of the patient. Black velvet is well known to give very little reflection. The column headed "detector facing skin" records the apparent intensity with the thermocouple reversed and the disc removed.

From these observations and a knowledge of the relative sensitivity of the blackened front and unblackened back of the thermocouple (fig. 5) we had hoped to estimate the approximate reflected intensity and hence deduce the real absorbed energy. It soon appeared that the observations were not likely to yield consistent reflection factors and the method requires further refinement. It is known (Pfleiderer, 1937) that some 40% of the incident energy is reflected in the visible, but that the factor is lower at longer wavelengths. Assuming a mean reflection factor of 20% for the high temperature source used, we have calculated the total energy absorbed during each treatment and hence the total absorption in the whole course. For the 25 cm. diameter lumbar field and in a twenty minute treatment the individual energy absorptions varied from 11,000 gm.calories to 19,600 gm.calories, amounts quite inadequate to account for the rise of body temperature on purely physical grounds. The total energy absorbed was 140,000 calories during the whole course.

Finally it may well be asked what conditions of treatment from a physical point of view should be specified in order to facilitate a useful interpretation of the data. Ideally we would like to specify four quantities, namely: (1) the intensity of radiation at every point on the skin; (2) the area irradiated; (3) the time of irradiation; (4) the energy distribution in the spectrum of the incident radiation.

We have, of course, normally no such information. It is, however, practicable to record: (1) the intensity of radiation in the centre of the field (or at the maximum if the two are not nearly the same) and at the edge; (2) the area irradiated; (3) the time of

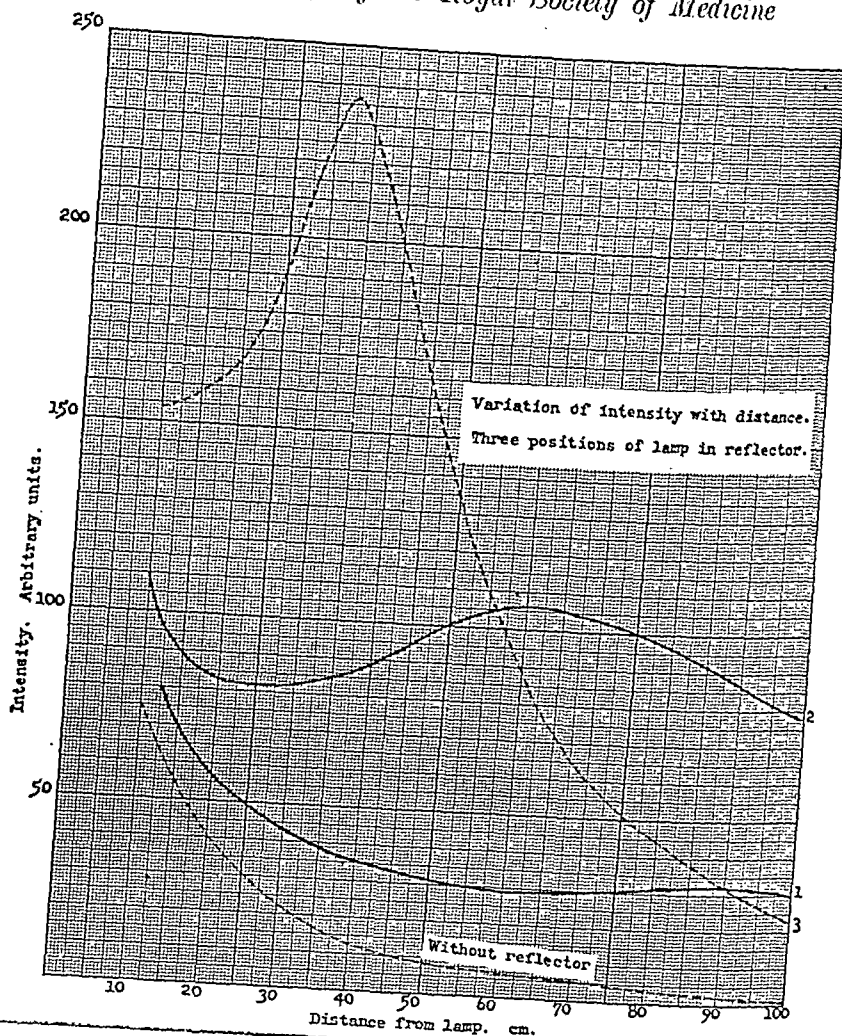


FIG. 9.—Variation of intensity with distance.

at certain distances as we approach the lamp the intensity actually decreases. Diffuse foci are formed whose positions may be roughly calculated from the standard formulae for spherical mirrors. We would emphasize strongly that the inverse square law does not hold; that the variation of intensity with distance is an extremely complex function of the relative position of the lamp and the reflector; and the only method whereby changes of intensity with focusing can be satisfactorily investigated is by direct measurement. We would also emphasize that variations of 300 to 400% can easily be caused by what may seem relatively small adjustments of focusing position.

#### TOTAL ENERGY ABSORPTION

As in other fields of radiation measurement for medical purposes, it seems likely that there are two physical quantities of significance, one determining the localized effect and the other the general effect on the patient as a whole. For example in the X-ray field we have "dose", that is energy absorbed per unit mass near a given point, which determines to a great extent the response near that point, while recently the importance of "integral dose", that is total energy absorbed by the patient, as determining general effects has been more clearly recognized. We are anxious to learn whether there are limiting factors other than local phenomena which govern the administration of radiant heat treatment and if so their nature, so that the appropriate physical quantity may be selected for investigation. It was therefore thought of interest to compare the amounts

JOINT DISCUSSION No. 4

# Sections of Dermatology and Physical Medicine

Chairman—H. C. SEMON, M.D.

(President of the Section of Dermatology)

[March 18, 1943]

## DISCUSSION ON THE APPLICATION OF PHYSICAL METHODS IN THE TREATMENT OF SKIN DISEASES

Dr. A. Rupert Hallam: I propose to confine my remarks to the action of X-rays and ultraviolet light in skin diseases. The practical application of X-rays has been developed entirely by dermatologists. So far they have done all the work, and X-ray therapy is just as much a part of dermatology as Lassar's paste.

Some dermatologists appear to use X-ray therapy with considerable reluctance. They almost regard its use as a confession of failure and feel they should be able to achieve the same result by other and perhaps simpler methods. I think that attitude is really a wise one, because with this remedy which does give some improvement in so large a proportion of skin cases there must be a tendency to neglect due consideration of the aetiology and pathology of the skin complaint.

With modern apparatus, there is almost unvarying output, and in addition quantimeters and various calibrating instruments assist us in standardizing the dosage. But there appears to be some confusion about the erythema dose, and I believe it has not been universally standardized, many workers having their own views. But the sensitivity of the skin varies with age, sex, position on the body, and, above all, size of field. Unless all these and other factors are taken into consideration it is impossible to compare one erythema dose with another. Fortunately it is seldom that we have to use an erythema dose; with the spaced fractional dose there is very little danger of any serious results from over-treatment, and even with the epilation dose, I believe, there is a margin of safety of 25%. In this country we appear to assume that 400 r units are equivalent to the epilation dose, the erythema dose, and the tint B. But I find that in that comprehensive book by MacKee, "X-ray and Radium Treatment of Skin Diseases", 1938, a dose of 300 r units is mentioned as being equivalent to the erythema dose and the epilation dose. That, of course, is unfiltered radiation. Another author (Ellinger, "Radiation Therapy", 1941) has published a book in New York since the war and quotes figures as follows: for an area of  $2 \times 2$  cm. the skin erythema dose is equivalent to 450 r, but for an area of  $6 \times 8$  cm. it is 400 r, so that his figures are almost identical with our own. The discrepancy between the figures quoted by these authors is large. How has the difference arisen? There has been a considerable amount of research on the action of X-rays. According to Ellinger there is no specific morphological irradiation effect, but, of course, it is accepted as a certainty that exposure to X-rays does reduce inflammatory reactions.

MacKee gives a list of ninety skin diseases which are more or less amenable to X-ray therapy. In the first place, are we entitled to treat malignant disease of the skin with X-rays? For many years I treated large numbers of rodent ulcers with some success, but during the last ten years I have referred all such cases to the Radium Department, and I am quite convinced that the results obtained by that department have been better than I could have achieved myself. Therefore I question whether we are really justified any longer in treating malignant disease of the skin.

The role of X-ray therapy in the treatment of acne vulgaris is a subject which needs some consideration. This is a complaint which causes considerable misery to young people, and we all know that X-ray therapy probably gives quicker results than any of the other methods which are based on improving the general health, so that it is very tempting to use it in all cases and at the same time very difficult to make the afflicted person realize that attention to such matters as local sepsis, more fresh air, and so on is equally important. It has been assumed that the beneficial effects are due to inhibition of the sebaceous glands owing to the action of the rays, but some years ago H. D. Niles

irradiation; (4) the "quality" of radiation, that is to say the nature of the source including its running conditions.

The careful recording and analysis of such data for a large number of patients could scarcely fail to yield important information as to the most appropriate amounts of radiation to be used in various circumstances. Such studies might define the maximum radiation beyond which increase is dangerous, the minimum radiation of real value and provide a basis upon which more exact and quantitative physiological studies might be built.

#### SUMMARY

The paper contains an account of theoretical and experimental work on the measurement of non-ionizing radiations, particularly infra-red and visible light. Reasons are given for suggesting that the incident intensity of radiation in therapeutic practice should be measured in gm.cal./cm.<sup>2</sup> min. From such data energy absorption in the patient may be approximately deduced. The absorption in celluloid of radiation from sources of different colour temperatures may form the basis of a "quality" measurement of infra-red.

The standards of radiation measurement employed are a Moll microthermopile with a fluorite window, calibrated by the National Physical Laboratory, and a 40 watt carbon filament lamp calibrated at the National Bureau of Standards, Washington. The two calibrations are in agreement. Small vacuum thermocouples have been used in the construction of a clinical instrument whose characteristics were carefully studied.

Measurements on patients show that the intensities of radiation employed in practice are frequently of the order of 2 gm.cal./cm.<sup>2</sup> min. The threshold for pain appears to be 3 to 4 gm.cal./cm.<sup>2</sup> min. The distribution of radiation over a plane perpendicular to the axis of the beam has been studied as well as that over the surface of patients being treated in radiant heat cradles. A study was also made of the variation of intensity with distance from a lamp in a reflector. The paper concludes with a discussion of total energy absorption and the most appropriate quantities to measure in practice.

*Acknowledgments.*—We have been greatly aided in these studies by a number of our friends and colleagues. We would particularly like to acknowledge the loan by Major C. E. S. Phillips of a thermopile with which some of the earlier work was carried out, as well as the helpful information as to equipment and procedure given by Mr. J. Guild of the National Physical Laboratory, who also kindly calibrated the Moll thermopile for us. We also wish to thank Dr. W. W. Coblentz and the Director of the Bureau of Standards, Washington, for the gift of the standard of radiation; and the General Electric Company of Schenectady for the gift of the vacuum thermocouples used by us in the clinical instrument.

Finally, we wish to thank our medical colleagues, Dr. Flood and Dr. Smithers, for their interest and advice, as well as for allowing us to make measurements during the treatment of their patients. We wish also to record that many of the measurements on the patients were very carefully made for us by Miss Page-Roberts, to whom our thanks are due.

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I will proceed with the consideration of some common skin conditions.

*Acne vulgaris*.—*Acne rosacea* is excluded because it has been found that in most cases the condition is aggravated by ultraviolet irradiation. The number of cases was 865. Of these 295 were males, 553 females and 17 children under 16 years of age. The results recorded were 596 improved, the remainder were not improved or had less than 12 treatments or were lost sight of. Approximately 66% of the women, 55% of the men and all the children improved.

The technique which has been found to give the best results differs in the pustular type of case from that in the non-pustular type. In both, the treatment is local and general.

**Technique in the pustular type:** The skin is cleaned with spirit to remove dirt and grease. An exposure of ten minutes is given with the non-luminous infra-red generator, followed by the mercury arc, of sufficient intensity to produce, on normal skin, a well-defined or third degree erythema. The object is to secure marked desquamation followed later by pigmentation.

**Technique in non-pustular type:** The same cleansing is adopted because dirt and grease prevent the shorter ultraviolet rays reaching the skin. The preliminary exposure to infra-red is not necessary and only a milder or first degree erythema is necessary.

The physiological basis is largely speculative. For the intensive local treatment it may be said to be purely mechanical, the "peeling off" of the superficial layers of the skin and so opening up the pustules. It is possible that there is a bactericidal action due to the short ultraviolet rays sterilizing the skin, or at least inhibiting the growth of organisms, and stimulating the skin to bring about its own salvation. As for the general treatment, the stimulation of endocrine activity and the increased production of vitamins are generally recognized as biochemical results of irradiation and possibly are the explanation.

*Psoriasis*.—The 247 cases examined include the early cases with few scattered lesions with thin papery scales and those with large areas with the thickened scaly adherent crusts. 103 were males, 128 females and 16 children under 15. Of these 185 improved and only 62 showed no improvement.

Seventy-two were given general treatment only: an almost equal number being treated with the carbon arc as with the mercury arc. 69 were given local treatment only, i.e. patches were singled out. In 40 of these the tungsten arc was used; 26, the air-cooled mercury arc; 3, the Kromayer. In addition 17 were given X-ray. The remainder were started on one form of treatment and then changed to some other. The type that responds best is that with thin papery lesions.

**Technique:** The method is to single out groups and give third degree erythema doses. There is no advantage in blistering. Where large areas are affected general irradiation is the only practical method, at least in a clinic.

That type with thick scales and crusts does not respond well unless other treatment is associated with it. Effects are quite good when one of the usual ointments, e.g. chrysophane, is applied nightly. These remove the scales and allow the ultraviolet rays to have effect on the underlying lesion.

There is one type that appears to be made worse by ultraviolet rays. This is what might be called the acute stage, where the patches are inflamed and there is itching. Infra-red irradiation, however, results in immediate improvement and certainly gives the patient relief.

There can be no question of irradiation bringing about a cure. Many patients come back periodically, either in the winter months or the beginning of spring. Others say they prefer to keep the lesion under control by this method, which is clean, than be inconvenienced by the constant application of greasy ointments and recognize, even if the condition clears up, that they are not cured. Early cases seem to respond best.

*Eczema*.—This term is used in its widest sense. 92 cases were examined, 38 men, 30 women and 24 children. The average number of treatments given was 32 and the results show that the number improved was 24 men, 20 women and 15 children, making a total of 59, approximately two-thirds.

**Technique:** In all cases a slight first degree erythema dose was given and no attempt made to bring about either pigmentation or desquamation, the object being merely to raise the standard of general health. Local treatment was only given in addition when small localized areas were affected and the condition had persisted for years. A third erythema dose was given to those areas.

The weeping form does not appear to respond to any treatment in which the ultraviolet predominates; the non-luminous infra-red generator gives better results.

*Dermatitis*.—Of all skin conditions dermatitis appears as a symptom of some underlying cause, especially in the so-called "occupational dermatitis". These underlying causes after

(*Arch. Derm. & Syph.*, 1933, 27, 89) showed that there was apparently just as great an improvement if half of the skin was treated. The method of treating half the skin obviously is a great saving of time, and I wonder whether any members present have had experience of it.

What is the ideal technique in the treatment of acne vulgaris by X-rays? Is small doses weekly for three or four months, or is it a larger dose, say 200 r units, at intervals of three weeks, with a maximum of five exposures?

Another common skin disease is psoriasis. Of all the remedies described during the last hundred years it is questionable whether any is so reliable as X-rays, and yet in X-ray treatment all that we can hope for is a temporary improvement; we cannot expect a cure. In my experience some of the cases are extremely resistant to treatment and it is difficult to give a prognosis or to choose those which are likely to react well and those which are not. It is generally agreed that we should restrict treatment to a few of the lesions, and it is my practice to treat with X-rays only psoriasis on the face or hands. Psoriasis of the scalp appears to be particularly amenable, but I caused epilation in two cases with one-third erythema dose, so that I think it is a remedy which is not very applicable to the scalp.

I again express the view that there is a danger in regarding X-rays as a short cut in the treatment of skin diseases, and now pass on to a very brief consideration of the effects of ultraviolet irradiation. I have been very disappointed with it and do not regard it as of any great value.

About sixteen years ago Rollier assured me that much could be done by exposing patients in the open air even in the large cities in this country. I was sufficiently impressed to try out the effects in Sheffield, where, in those days, there was a large number of cases of lupus vulgaris. I established five centres, four of them on the outskirts of the city and one in the Royal Infirmary grounds, in the smoky centre of Sheffield. The patients attended daily. It happened to be a perfect summer and I found that they did not feel it at all irksome; they read, knitted, and played games, and were convinced that their general health improved. There was good bronzing and I was satisfied that there was greater improvement in the lupus patches than I had ever seen from exposure to the carbon arc or the mercury vapour lamp. I was astonished at the way even the people who were exposed in the Infirmary grounds progressed. The following year we started again, but that happened to be a wet and cold summer: all the patients became disappointed, and so did I, and we had to abolish the scheme.

When Dr. Lomholt was over for one of our meetings his enthusiasm about the effects of Finsen light so impressed me that I sent to Copenhagen for the latest lamp. I was fortunate enough to obtain a nurse who had been trained at the London Hospital, and we started the treatment of lupus vulgaris, but again with very depressing results. Every time I went to this department I found some technical fault. Eventually I discovered that there was a deposit of vegetable matter on the inside of the quartz lens. This was derived from the water which cooled the lens and which happened to come from the peaty moors in the neighbourhood of Sheffield. I am quite certain that this deposit had cut off most if not all of the short waves and I think it is very likely that it was responsible for my failures. But this was the last straw. I closed the department until such time as I could find a colleague with sufficient patience and enthusiasm to take it over from me.

**Dr. William Beaumont:** My comments are based on an analysis of cases that have been under my direct care at the Institute of Ray Therapy during the past thirteen years. This analysis cannot be as exhaustive as intended owing to the limitations imposed by shortage of both time and staff.

The use of the term "irradiation" is confined, for the purpose of this paper, to the ultraviolet, visible and infra-red rays. I am not unmindful of the value of other physical methods. The effectiveness of high frequency currents of low wattage ("violet ray") is relative to the degree of erythema produced. The high frequency current of high wattage (short wave diathermy) is of value for its heating effect. The former can be obtained by ultraviolet and the latter by infra-red. Ionization is an effective method of introducing drugs superficially into the skin, but its application is limited.

By designing the Finsen lamp for local treatment and employing the flaming carbon arc for general irradiation, Finsen was the first to establish a reasonable technique and embark seriously on the use of artificially produced radiations for the treatment of skin conditions. Later, about 1908, Dr. Kromayer designed the water-cooled mercury arc for local irradiations. In this country I think the credit should go to Dr. Sequeira who introduced to the London Hospital the Finsen technique.

Dr. R. T. Brain agreed that a safe standard for the erythema dose of X-rays at a kilovoltage of 90 was 400 r and with a current of about 3 ma. this dose could be adjusted to a treatment period of four to six minutes.

Dr. Brain had not found that many cases of psoriasis respond to irradiation alone but some of his patients responded well and remained free from lesions for very long periods. He had not been impressed by the results of local ultraviolet light therapy in psoriasis, which did not bear comparison with the excellent results of X-ray therapy although the latter were often fleeting unless the local therapy was part of a wider plan of treatment. General ultraviolet light therapy was often beneficial in eczema and many patients with infantile eczema attending the Hospital for Sick Children had recovered on careful exposure to the sky-shine and open air.

Dr. Brain referred to some of the other methods of physiotherapy used in dermatology. Thorium X was a useful radio-active substance and provided a method of utilizing the alpha particles to produce a superficial inflammation. Applied as a paint or varnish, favourable results had been obtained in the case of superficial vascular nævi, lichen simplex, psoriasis, &c.

Ionization and electrolysis were used to remove small moles, warts and superfluous hairs. Multiple warts could be effectively treated by ionization and Dr. Grace Griffith had obtained over 60% success with a 1% solution of sodium salicylate. By painting the warts first with 10% caustic soda the conductivity of the warts was greatly increased and then the whole limb could be put in the bath with the cathode and the maximum current tolerated passed for twenty to thirty minutes.

Dr. Philippe Bauwens: In acne vulgaris, it seems to me that the adolescent type which is due to an endocrine disturbance caused by male hormone production, responds well to stilbœstrol or some œstrogenic substance which does appear to slow down the glandular development. At the same time one should look to the patient's general condition and give general ultraviolet rays and possibly local doses of ultraviolet rays. I have been much impressed by giving 1 mg. of stilbœstrol per day for a month. I must add that I did so with the permission of the dermatologist at the various hospitals I attend.

With regard to psoriasis I have not experienced the disappointment mentioned by some speakers. I have seen some good results from treatment with ultraviolet light, but the treatment must be continued, the patient cannot be discharged. It may be possible to keep the condition at bay with one treatment all over the body once a fortnight; I have some policemen who attend for such treatment regularly and it seems to be satisfactory. It is quite true that the very resistant types, with thick scales, are difficult to deal with. All these cases we treat with the usual coal tar ointments, with sunlight baths and local application of the stronger reaction doses. In the cases with thick scales, one cannot obtain a third degree reaction, and I have then substituted carbon-dioxide snow for the ultraviolet rays. One can obtain good third degree reaction with carbon-dioxide snow dissolved in acetone painted on the scaly margin of the psoriasis.

I agree with Dr. Beaumont as to the treatment of lupus. To use a Kromayer lamp and order a fourth degree reaction of ultraviolet rays is not enough because the blister will be produced by the action of the short, superficially absorbed radiations. What one has to do is to ignore that portion of the spectrum and obtain the tissue reaction deeper down. In order to produce a deep reaction one has to rely upon a prolonged application with the Kromayer burner.

That is the answer to the controversy which has existed between the protagonists of the Kromayer lamp and the Finsen type of lamp. The latter depends on the ordinary short flaming arc, which is a source of radiations rich in long penetrating ultraviolet rays. As Dr. Beaumont suggests, in twenty minutes short radiations have done all the damage they can superficially; they will produce a blister, but what we rely on for the curative effect is the reaction produced more deeply by the more penetrating long rays. Therefore it is quite wrong to order a fourth degree dose of ultraviolet rays when using a mercury vapour lamp for lupus.

Impetigo: I have once or twice obtained good results with zinc ionization. I remember a patient who had an impetiginous skin reaction from furunculosis of the ear, which spread very rapidly despite all the remedies used. It was getting so near the eyes that I ordered about 400 milliampere minutes of zinc ionization to be given and the result was most gratifying, one treatment made an enormous difference and the condition subsided after about four daily treatments.

Herpes zoster: In these cases I follow the same type of technique—a good sharp dose



a while bring about a lowered state of the physical condition, e.g. a lessened resistance to infection. The tonic sunbaths, so widely used in industry to-day, are of real value in these cases.

In those occupations where the employee is exposed to a known skin irritant, the value of ultraviolet irradiation is doubtful, in fact one could almost say that it is contra-indicated. As for the non-occupational conditions and where the dermatitis may be an expression of "constitutional disturbance", e.g. endocrine dysfunction, anxiety state, defective circulation or plain ill-health, then suberythema doses of ultraviolet and visible irradiations combined are effective. In all, 218 cases were examined and of these only 80 showed no improvement.

*Impetigo*.—This is a condition which gives really gratifying results if treated early and energetically. Of 84 cases, 56 completely cleared up in 20 treatments. The technique adopted is as follows: The scab is removed and a marked third degree erythema dose given. General treatment is always given and this is of the utmost importance as the child is usually in a debilitated state.

*Herpes*.—This is a symptom of a nerve condition rather than a skin disease. If a first degree erythema dose is given each day to the lesion within the first three days, these distressing blemishes will quickly dry up and disappear and rarely does the neuritis persist for any length of time.

If neuritis is present, either infra-red or diathermy is given, according to the severity and distribution of the pain. In all cases this is combined with general irradiation in suberythema doses. 27 cases were treated and of these 20 completely cleared up.

*Tuberculous affections of the skin*.—The secondary infection which may follow operative interference in adenitis and in some cases of tuberculous osteomyelitis will respond to irradiation if taken in hand in the early stages, but it is most intractable if they have been allowed to go on for months. The local treatment should not be confined to the actual area involved but should include as much of the surrounding healthy skin as possible, and only a first degree erythema dose given. The general irradiation is of great importance and should be similar to the treatment of lupus vulgaris.

*Lupus vulgaris*.—It is unfortunate that the correct technique laid down by the pioneers of this treatment is so rarely carried out. It is largely because of this that one hears of disappointing results.

The total number of cases under observation is 60. Cases of lupus are never discharged but reviewed from time to time. In 4 cases the lesions were early and no larger than a shilling, and without exception they cleared up leaving only a scar which has become less noticeable as the years have passed.

*Technique*: Intensive local and prolonged general treatment is given. Locally the Kromayer lamp is used, pressed hard against a chosen area the size of a shilling. The time is never less than fifteen minutes. Three, sometimes six, applications are made with one day's interval between, followed by a rest of fourteen days during which another spot is dealt with. If granulation tissue cannot be seen, the process is repeated to the first area. Long exposure at contact is the first consideration, the production of a blister is incidental but inevitable. Saturation of the area with irradiation is the keynote to success.

This technique applies to that type of lupus characterized by the presence of "apple-jelly nodules" before they have broken down, and also where there are only small areas of ulceration. Where there are large superficial areas of ulceration it is not so effective and these cases require gentler handling. Only a mild erythema dose should be given and not at contact.

While the value of local treatment, if correctly carried out, can hardly be denied, general irradiation is more universally accepted. Repeated erythemas should be procured so as to produce pigmentation. These patients do not pigment easily, but the prognosis bears a definite relation to the success or failure to bring this about. It is necessary to give up to twenty minutes back and front, three times a week, starting with an exposure which produces a well-defined erythema and advancing every third treatment until the maximum is reached. Even when the skin has pigmented treatment is continued until the local lesion is under control.

#### CONCLUSION

In skin conditions general irradiation, in many cases, plays a greater part than local. The combination of the radiant heat lamp with the mercury arc gives the better results, unless the carbon arc is used. Infra-red is a useful form of local treatment in a few conditions. In my opinion the hopes of some workers in the early days of the introduction of ultraviolet rays have not materialized, but there are few skin conditions in which irradiation will not prove a useful auxiliary form of treatment.

**Pruritus ani and vulvæ.**—Rapid improvement after 300 r of soft rays on three occasions with weekly intervals. Proctitis, hæmorrhoids, and parasites must be considered individually otherwise relapse is unavoidable. In generalized pruritus general grenz ray treatment gives relief.

**Lupus vulgaris.**—The most favourable results can be obtained in well-confined fresh lesions with some surplus of connective tissue. More difficulties arise in the treatment of extensive confluent old lesions. As in every chronic disease no permanent local success can be secured without sufficient care of the general condition of the patient (rest, fresh air, good diet, plenty of vitamins, &c.). The histological changes in the lupus tissue after grenz ray treatment may be described as follows: the capillary flow increases considerably, leucocytes immigrate and exudation of serum occurs into the surrounding tissues. This is followed by a breakdown of the irradiated parts and phagocytes deal with the debris. Repair and regeneration are carried out afterwards by immigrated fibroblasts and connective tissue cells. The process of regeneration depends on the amount of remaining healthy connective tissue and on the state of the blood and capillary vessels in the subcutis.

In some cases it has been found that the superficial lesion healed up quickly after grenz ray treatment but granulations remained in the depth. As far as could be established these cases had been treated by the excessive doses of very soft rays of Spiethoff's technique (single doses up to 10,000 r with total doses up to 80,000 r). We recommend a more conservative line. Before starting treatment an explorative dose should be given. This may be about 1,000 r in an ulcerative case or 1,500 r of medium rays in a case of lupus tumidus. Maximum reaction is to be expected in about two weeks' time, another flare up in four to five weeks. Treatment is of little avail without a definite reaction consisting of erythema, swelling, discharge and soreness. To produce the reaction subsequent doses may be increased up to 2,000-2,500 r. This dose was rarely exceeded by us in recent years and it was combined in ulcerative forms with softer, and in verrucous forms with harder, radiation. Success depends to a great extent on keeping long enough intervals between individual applications. No treatment should be repeated on the same field before eight to sixteen weeks have elapsed since the last application. Total doses 10,000-25,000 r.

**Tuberculosis verrucosa cutis.**—Results are uniformly good with 1,000-3,000 r of hard rays in monthly intervals. Total doses according to hyperkeratosis 5,000-15,000 r.

**Nævus flammeus.**—Treatment of portwine stain with carbon dioxide, X-rays or radium are all unsatisfactory and grenz ray therapy yields the best cosmetic results. As the therapeutic dose lies very near to the damaging dose great care is necessary, especially in adults. Best results are achieved in young children. They are less satisfactory with increasing age, especially in the deep type. Still even in these cases a considerable decrease of the redness occurs with partial involution. Dosage must be chosen individually and very carefully, covering is most essential. On an average ten to twelve sittings are necessary with 600-800 r each time in children, 800-1,000 r in adults, with five to six weeks' interval between each application.

**Scleroderma.**—In the localized form quite favourable results can be obtained, especially in the fresh stage and not exceeding 2 in. diameter, with 200-300 r of hard rays repeated five to ten times.

**Keloids.**—In fresh keloids we had quite good results either with large doses of 1,500 r of hard rays in intervals of eight weeks or with fractionated doses, beginning with 500 r of hard rays, later doubling and trebling the dose at each exposure until 8,000-10,000 r had been given.

**Plantar warts.**—Very good results were obtained by giving 2,000-3,000 r of hard rays, repeated, if necessary, with four weeks' intervals. Sometimes one single application was sufficient, in most cases three treatments were necessary.

(Dr. Leitner also discussed the use of grenz rays in dermatitis herpetiformis, parapsoriasis, Bazin's disease, alopecia, poikiloderma atrophicans vasculare Jacobi, arborescent telangiectasia, Darier's disease, and rodent ulcer.)

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Dr. H. C. Semon : Dr. Whittle has asked me to draw your attention to the fact that many patients having X-ray treatment from one dermatologist, often go to another. Should not some scheme be set up to register and follow up such cases so that if the

of ultraviolet rays locally. I always give short wave to the part near the spine so as to include the affected dorsal root ganglia. I have had good results providing it has been caught within the first three or four days.

**Dr. Z. A. Leitner:** Grenz ray treatment for skin diseases has been carried out in the Physiotherapeutic Department of St. Mary's Hospital since autumn 1936. It is proposed to give here only a short summary of our experiences

Grenz rays are X-rays of a very long wavelength (3-1 Angström units). They are produced by applying a voltage of 5-12 kV. to a special tube the aperture of which is made of Lindemann glass. The glass is constructed of boron, beryllium and lithium, substances of low atomic weight which permit the passage of a very soft radiation.

Before the grenz rays reach the skin they have to pass through a layer of air which changes to a considerable extent their quality and quantity, a filtering and hardening of the spectrum taking place that is to a certain extent similar to that obtained by increasing the voltage. With increasing thickness of the air filter the maximum is shifted gradually to the hard side; the steepness of increase and decline is greater and the region of maximum is contracted.

As the penetration of rays is inversely proportional to their wavelength, grenz rays with their long wavelength will be nearly quantitatively absorbed in the upper layers of the skin and only a minute fraction penetrates to the vessel-bearing layers. The intensity of grenz rays of about 11.5 kV. eff. (8 kV. max.) is reduced to about 40%, 20% and 12% respectively of their initial value through absorption in 1, 2 and 3 mm. of skin. X-rays, however, are only absorbed to an extent of about 8.5% with 30 kV., 3% with 60 kV. and 1% with 100 kV. in the first 3 mm. of the skin, 91.5%, 97% or 99% respectively penetrating to the deeper tissues. This means that, whilst nearly the whole applied grenz ray energy is effective in the skin itself, only about 5% of X-rays will be utilized in the same way; 95% of X-rays will penetrate and damage the deeper-lying germinative tissues, the network of nutritive vessels which are indispensable for regeneration.

Biological properties of grenz rays are very intensive on account of the amount of absorption. The course of erythema consists of four waves, which I have described fully in an earlier paper (*Brit. J. Radiol.*, 1937, 2, 586). If the skin lesion is covered by a thick hyperkeratotic layer, rays of harder quality are necessary in order to obtain an optimal effect. More intense erythema and pigmentation are to be expected when harder rays are applied. Persons vary in their sensitivity to the rays and there is also a variable regional sensitivity in the same individual, e.g. the anterior aspect of the neck, the flexor aspects of the extremities, the face, eyelids, ears, popliteal and antecubital spaces are specially sensitive. Strong cutaneous reactions and the principal erythema can in most cases be avoided by fractionization so as to prevent possible late ill-effects like atrophy, telangiectasis and pigmentation. These occur occasionally if precautions are not carried out. Depilation, ulceration and malignant changes have never been recorded in man.

**Indications for grenz rays.**—Acute dermatitis with œdema and profuse exudation, or secondary infections with pus formation, as well as previous X-ray treatment are definite contra-indications for this treatment. In stating the doses the following designation will be used for simplification: soft quality corresponds to a half-value layer in aluminium of 0.016 mm., medium quality to 0.024 mm. and hard to 0.036 mm.

**Dermatitis.**—In acute cases with moderate erythema and exudation small doses (100 r) every second day for a week. In subacute eczema about 50% more, and in chronic cases with lichenification 3-400 r of hard rays every fourth to fifth day, altogether 1,000-1,200 r. When hypersensitivity is present or in cases of neurodermatitis with marked thickening 100-150 r of hard rays every second day are advisable. In seborrhœic dermatitis 100-150 r of soft rays twice a week, altogether 500 r may be given. On the hairy scalp twice as much should be applied with harder rays.

**Acne vulgaris.**—Good results in superficial types. 200-300 r of medium rays twice a week.

**Psoriasis.**—It is contra-indicated in acute cases. Psoriatic patients are often sensitive to ray treatment. Small doses (200-300 r) of soft rays with strict avoidance of erythema should be given. Rapid improvement occurs in most cases if precautions are not neglected. Larger doses up to 1,000 r are necessary on the hairy scalp and nails. In many cases no relapse occurred for years but as the ætiology is not yet understood no promises can be given. In case of relapse repetition of grenz ray treatment is certainly indicated. We have never seen any acute exacerbations in our cases as described by Kalz (1941).

JOINT DISCUSSION No. 5

## Section of Odontology with United Services Section

Chairman—Surgeon Rear-Admiral J. FALCONER HALL, C.M.G.

(President of the United Services Section).

[April 19, 1943]

### DISCUSSION ON ULCERATIVE GINGIVO-STOMATITIS (TRENCH MOUTH)

Brigadier Stobie: A great diversity of opinion exists as to the correct interpretation of observations made on ulcerative gingivo-stomatitis. This may be partly due to the fact that a certain amount of confusion has been caused by differences of opinion as to whether patients presenting pathological gum lesions are, or are not, suffering from this condition. Some base their diagnosis mainly on clinical findings, others rely more on the bacteriological findings. This has resulted in rendering statistics unreliable. I feel that if we are to make any progress it is essential to direct our attention, primarily, to the consideration of that disease which fulfils the conditions at least indicated by its name and about the diagnosis of which there is some general agreement. Dental surgeons are more familiar with the condition occurring on the gums and known to us as acute ulcerative gingivitis, whereas our medical colleagues will perhaps have had more experience of its occurrence on the fauces and pharynx with or without implication of the gums and the buccal cavity, the former recognized as Vincent's angina and the latter a true stomatitis.

The disease is characterized by a rapidly spreading ulcero-membranous destruction of the gingival margin usually commencing in some area of stagnation such as the gum flap over the erupting lower third molar or the uncleansable interdental spaces between teeth in malalignment. Extension is by continuity of tissue, and, dependent upon the starting point and the direction of spread, the result may be a gingivitis on the one hand, or ulceration on the fauces on the other.

More especially does the latter occur when it originates in the neighbourhood of the lower third molar. Contiguity does not appear to play a very great part in the process, the tongue is rarely involved and although there may be severe and widespread ulceration of the gums, the cheeks and lips are not proportionately affected.

The subject of a mild attack or one who receives prompt initial treatment is not greatly incapacitated, but when the attack is severe and occurs in an uncared part in the process, the tongue is rarely involved and although there may be severe and widespread ulceration of the gums, the cheeks and lips are not proportionately affected. The subject of a mild attack or one who receives prompt initial treatment is not greatly incapacitated, but when the attack is severe and occurs in an uncared part in the process, the tongue is rarely involved and although there may be severe and widespread ulceration of the gums, the cheeks and lips are not proportionately affected.

patient changes his doctor the actual dosage and quality of rays and filtration used by the first will be available to the second? When patients are going on for continuity of treatment to some other dermatologist or physiotherapist in a different country or colony they should be given a schedule which would make it possible to avoid disaster in such treatment.

**Dr. W. N. Goldsmith:** Dr. Leitner mentioned a number of very rare skin diseases which react perhaps better to grenz rays than to anything else, but it is in certain very common diseases that I have found them such a boon, particularly in the form of eczema that we call neurodermatitis or Besnier's prurigo, which can be so terrible to treat. I have had several such cases of great severity which had not responded at all to tar or peptone injections and which cleared up rapidly with grenz rays for a very long time; when they did recur, they responded again.

Some cases of exogenous dermatitis, or eczemas of the hands and forearms which we are very apt to call occupational dermatitis, respond to grenz rays much better than to X-rays.

The indications for grenz rays and for thorium-X overlap to a certain extent, although the actual character of the emissions are totally different; both are particularly useful in those regions of the body where the skin covers organs which deeper X-rays would damage, for instance the scrotum, eyelids, or the scalp when epilation is to be avoided. Grenz rays have the advantage over thorium-X where it is desired to treat a large area of the body; a modern grenz ray tube gives a fairly even dosage over a wide field.

I should like to emphasize Dr. Leitner's point that the distance at which the tube is used makes a great difference. A greater distance means a thicker filter of air, which reduces the intensity, but increases the average hardness of the beam. The harder grenz rays are more erythema-producing than an equal r-dose of the softer grenz rays.

I should like to mention one method of physical treatment which has not been touched upon to-day, and that is sinusoidal current used as a bath for conditions such as chilblains, erythrocyanosis frigida and the "blue leg" following infantile paralysis. I have found it extremely useful, and think its merits are not widely enough appreciated.

**Dr. E. J. Crisp** agreed with Dr. Bauwens that acne in adolescents was often due to endocrinic deficiency. Prior to the war he treated young males with local and general sunlight, and in addition bi-weekly injections of antuitrin "S", a Parke Davis preparation. The results were excellent and it was possible that bi-weekly injections of antuitrin "S" might be effective, without the employment of sunlight.

Zinc ionization he had found exceedingly useful in healing indolent wounds which failed to respond to local ultraviolet irradiation, and its use should always be considered in cases of this type.

**Dr. Beaumont** (in reply): I have only dealt with one form of physiotherapy. Aerated brine baths are useful in many skin conditions and the value of general irradiation which has been referred to is, in my opinion, of the utmost importance. I understand that an early case of lupus has cleared up with general treatment only. In cases of acne a change from one form of treatment to another has often brought improvement thus suggesting a psychopathic origin for the affection.

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The subject of a mild attack or one who receives prompt initial treatment is not greatly incapacitated, but when the attack is severe and occurs in an uncared for mouth or is left untreated for even a relatively short time, patients are definitely ill, and show all the signs of acute toxæmia. A more or less constant feature of the disease is the most unpleasant factor associated with it, and its presence is generally sufficient at least to make

a tentative diagnosis. The membranous exudate varies in colour in different cases, being grey or yellowish grey, and follows the irregular outline of the affected part. Most commonly the gums are intensely inflamed and bleed very readily on the slightest injury.

It was inevitable that with the experience gained during the last war, there should have been anxiety about what was likely to happen under the unknown conditions associated with the congregation of masses of people in times of stress and closely herded together in air-raid shelters. Similar concern was felt about the effect upon men, of the sudden transition from civil to military conditions of living. Fortunately, the anticipated has not materialized, and certainly in the case of the Army the insistence upon the early recognition of disease by both dental and medical officers, together with the co-operation of officers in command of units, may have had much to do with the avoidance of what was confidently predicted would be a menace.

*Ætiology.*—The cause remains obscure. Many suggestions have been made but none has been wholly satisfactory nor is there agreement upon whether it is a communicable disease, contagious or infectious in character. There does not appear to be the constant factor of lowered resistance, but, even so, I think that in all cases there is, in addition, some predisposing local departure from the normal, often trivial in degree, yet sufficient to permit its lodgment and development. To illustrate my meaning and perhaps place the incidence of acute ulcerative gingivitis in proper perspective, here are the findings of an investigation of the condition of the gums and mucous membrane of roughly 1,200 men, drawn from all walks of life, and varying in age from 19 to 52. Some had come from industrial, and others agricultural, areas, or had spent at least six months in one or the other. The standard of normality was purposely high and any departure from it was recorded in one of three classes, viz.:

*Slight gingivitis* (263) nearly always present as might be expected where there was malalignment and confined to that particular area.

*Gingivitis* (270) where there was a definite marginal or general inflammation but no pocket formation.

*Parodontal disease* (140) varying in degree from early destruction of the parodontal tissues with pocket formation to a few who presented with extreme destruction; deep pockets and loosening of teeth.

This total of 673 all possess tissues with evidence of injury. Of the total, but not included in the 673, there were only eight cases which by any stretch of imagination could be called acute ulcerative gingivitis .6%. An observation not directly associated with this discussion was the number of cases of parodontal disease, 140 or nearly 12%, a figure much lower than I had previously believed expressed its prevalence. We thus have an appreciable number of subjects with local lowering of resistance favourable to the aggression of any of the multitude of organisms which may be present in the mouth.

Of recent years with the ever-increasing knowledge of biochemistry and the very important part played by the accessory food factors in health and disease, deficiency of one or more of these factors has been suggested as a predisposing cause, and much painstaking investigation conducted on this assumption. Vitamins B and C have received most attention, but although beneficial results have undoubtedly been obtained by the exhibition of ascorbic acid or nicotinic acid as therapeutic measures, it does not necessarily follow on that account that there is any specific causal relationship. It is well known that individuals deprived of these important substances, or who for one reason or another are unable properly to utilize them, do show characteristic evidence in the mouth, but only when teeth are present. This is significant and might be taken to indicate a relationship between scurvy for example and acute ulcerative gingivitis, and in fact we hear the term subcurvy applied somewhat loosely to pathological conditions of the gums the cause of which is not readily ascertainable or has not been very carefully sought.

Great attention has been paid to the role played by vitamin C as a factor in the ætiology of acute ulcerative gingivitis. Investigations have been conducted with the object of ascertaining the relationship, if any, existing between the degree of saturation with ascorbic acid and the condition of the oral mucous membrane. In the case of the experiment carried out by the Army authorities 1,200 soldiers were examined but from the estimated initial degree of saturation or the number of doses of ascorbic acid necessary to produce saturation there was no evidence which could be interpreted as supporting any such relationship. An analysis of the results obtained in the cases of severe parodontal disease was equally unhelpful, some of the severest clinical cases appeared to be saturated whereas less severe cases were unsaturated. I believe similar results have attended investi-

gations carried out by the naval authorities. Great credit should be given to those self-sacrificing workers who are doing so much to establish whether the disease is contagious or not. Material upon which to conduct experiments is very limited, and they have perforce used themselves as the media. King (Surg. Commander C. C. Ungley and J. F. S. Horton, *Lancet*, March 27, 1943) has recently reported the successful transmission of it to himself. Indirectly, contagion has been taken for granted. Instructions given to sufferers and others lay very great stress upon the precautions which should be taken to prevent spreading the complaint, the cleansing of crockery, cutlery, &c., the supervision of conditions obtaining in the kitchens, cookhouses, including the dental state of personnel all point to the belief of its contagious nature, and two instances might be cited as suggestive: One an outbreak which occurred in a unit at a time when there was a great shortage of mugs and 19 out of 108 men were affected, and the other occurring at an isolated A.A. site where the only supply of drinking water was in a bucket and use was made by all of a common dipper (an old shell case). The officer contracted a very severe attack and his men were infected to a greater or lesser extent. Similar cases have been reported from time to time and such evidence as they furnish should not be disregarded.

That it is the oral manifestation of some general disease has also been considered as a possible explanation, and certainly we do meet in leukæmia and agranulocytosis, lesions in the mouth bearing some resemblance to acute ulcerative gingivitis, whom which it is extremely important to differentiate, for the consequences to the patient of mistaken diagnosis and inappropriate treatment are indeed very grave.

The general opinion is that whatever the predisposing cause, the *B. fusiformis* and Vincent's spirochæte are the organisms chiefly concerned. They can nearly always be demonstrated both in material taken from the ulcerated surface and actually within the gum tissue itself. Histologically their presence does not show marked leucocytic reaction and this might signify a lowering of the local reaction to injury. In a typical smear numerous and various other organisms are present, not any one or two of which have so far produced ulcerative gingivitis when attempts have been made to transmit the disease. The bacteriology of the subject is very involved and it is unsafe at present to say which, if any, are the principles, or to base a diagnosis on bacteriological findings alone.

The role of the virus has not escaped suspicion as a cause together with the question of droplet infection but here again further reports are awaited.

From reports received the greatest success in treatment has been obtained by the use of oxidizing agents, such as chromic acid, peroxide of hydrogen, potassium chlorate, sodium perborate, &c., either alone or in combination, their use being to create an environment inimical to the growth of anaerobic bacteria. Equally good results are claimed for antiseptics and caustics such as phenol and the aniline dyes, whilst iodine either in weak or strong solution or produced in the nascent state has its advocates. To combat the activities of the spirochæte, arsenic preparations were the obvious choice, and they have been used both as local applications, as with liquor arsenicalis, and by intravenous injections of, for example, N.A.B.

Equal success has attended physiological therapeutics such as the use of hypertonic saline, and there is much to be said for the value of controlled lavage with such simple compounds.

Any deficiency of accessory food factors is met by the exhibition of substances like ascorbic or nicotinic aids, alone or in combination with local treatment and here again results have been encouraging.

To provide rest and protection of the injured part from the repeated injuries associated with the taking of food, thereby giving Nature a chance to assist in the healing process a principle very much like that practised by Unna for the treatment of varicose ulcers has been adopted in the form of a supporting and protecting splint for the gingival margin and the necks of the teeth consisting of zinc oxide and oil of cloves, &c. It is carefully applied to the affected areas and greatly contributes to the comfort and well being of the patient. Surgical measures such as gingivectomy may be indicated in certain resistant cases, but I should oppose its use in any acute stage. The recurrent attacks which afflict a certain number of patients are a problem requiring further controlled investigation. Are these cases of true recurrence or exacerbations of the original infection lying dormant in inaccessible spaces? Is it found in the patient with normal gums, in whom the infection originated in the gum flap over a lower third molar which has been removed? Or are recurrences due to acute ulcerative gingivitis superimposed upon chronic parodontal



disease? At present I do not know the answer, but undoubtedly there are a few cases in which the only solution is the removal of the teeth which by their presence furnish foci of stagnation. In this connexion I am not advocating such drastic measures to replace painstaking conservative treatment but as in parodontal disease, there comes a time when the loss of the teeth and the subsequent welfare of the patient has to be carefully balanced.

**Surgeon Commander (D) E. R. Longhurst, R.N.:** At a large new entry establishment 22,675 new entries, aged on an average 21 8/12 years, were examined on entry into the Royal Navy.

During the same period 660 artificer boys aged 15 years were also examined.

Of the first group 19.2% of the mouths were in good condition, 59.1% were fair and 21.7% were neglected. Over the entire group an average of 2.05 extractions, and 5.7 fillings were required per man. Of the second group, 38.7% of the mouths were in good condition, 59.4% were fair and only 1.9% were neglected. This group required an average of .58 extractions and 4.25 fillings per boy.

The incidence of ulcerative gingivitis among the first group was .17%, and among the second group NIL.

It is to be observed that these groups are from different strata of society, but the dietetic factor is at this time quite clear for the diet of the nation as a whole is standard.

When the two groups were combined and considered as a whole, among 4,953 neglected mouths the incidence of the disease was .545%, among 13,793 fair mouths the incidence was .080%, and in 4,589 good mouths there was no case seen.

It seems then that there is a relation between oral sepsis and incidence, and that the greater the degree of oral sepsis the greater is the incidence of the disease. For in those patients who presented signs of the disease, gross oral sepsis was present in 58.6% of 173 severe cases and 29% of 38 cases of less severity. Minor oral sepsis was present in 41.4% of the severe and 71% of the less severe cases. No case was seen with an absence of oral sepsis.

The degree of oral sepsis was assessed as the case progressed to cure and the pre-existing condition of the mouth could be judged. The degree of severity was based partly on clinical appearance, and partly on time to cure.

Leaving out other aetiological factors, these figures show that the greater the degree of oral sepsis the greater is the severity of the disease.

Selecting from among men not suffering from the condition 25 cases with marked oral sepsis three smears were taken from each mouth and examined for the *spirochæte* and *fusiformis*. At the same time 25 men with clinically clean mouths were examined in the same way. In the septic cases the organisms were numerous in 40% of the cases; fairly numerous in 20% of the cases; less numerous in 20% of the cases; scanty in 16% of the cases; absent in 4%.

In the clean cases the organisms were scanty in 12% of the cases; absent in 88% of the cases.

We see then that the greater the oral sepsis the higher the concentration of Vincent's organisms.

Cases presenting signs of the disease were similarly examined for Vincent's organisms.

They were very numerous in 90.8% of 87 severe cases and in 65% of 38 less severe cases. They were numerous in 9.2% of the severe and in 35% of the less severe.

In these cases then, the greater the concentration of Vincent's organisms the greater is the severity of the disease.

There is nothing here to prove that the *spirochæte* and *fusiformis* are definitely the causative organisms but there is a significance that is worthy of consideration.

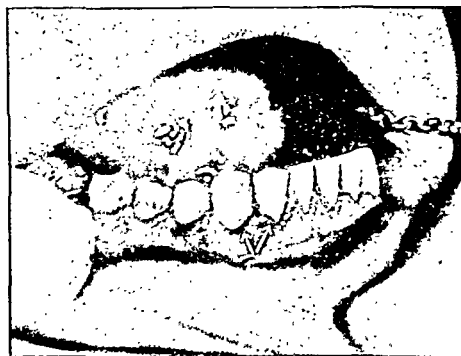
Since the *Lancet* article ((i), 232, 1942), there has been a revived interest in the herpes simplex virus as a possible causation, and writers have quoted the work of Mc Nair Scott and Steigman, Dodd, Bonnington and others mentioned therein, who have demonstrated the presence of the virus in the mouths, and the anti-bodies in the blood of children suffering from gingivo-stomatitis epidemically, and who suggest that the condition may occur in adults who have escaped childhood infection. The condition, however, seems to be of a different character from that with which we are familiar and in which the *spirochæte* and *fusiformis* predominate. I have seen two cases in the last year of herpes of the lips occurring coincidentally with an ulcerative gingivitis.

Without, however, ascribing the condition definitely to the number, type, mode of action, or spread of any particular organisms, or group of organisms, the fact remains

that the disease does not occur in clean mouths, and that it does occur in some, though not all, septic ones.

In considering the condition that will allow organisms existing saprophytically to exert their pathogenicity the local causes, such as erupting teeth, local trauma and extraction wounds, are to be examined. One sees many cases in which the eruption of a lower third molar has precipitated a localized ulceration of Vincent's type, whereas the incidence following dental extractions in mouths which have a high degree of sepsis present is very low. It seems that the socket and clot are well able to look after themselves and that the resistance of the area is not lowered and may even be raised by the hæmorrhage. *It is not the acute but the more chronic condition that seems to reduce resistance below the danger point.*

An interesting case of metallic poisoning which by its local manifestation falls into this category was seen. He was a rupial syphilide who had had stabismol pushed over a period of nineteen days. He developed a bismuth stomatitis of normal character which, two days later, flared into a typical Vincent's infection.



[Arrows indicate blue line referred to in text.]

At the time the photographs were taken the ulceration was not of the Vincent's type. There was no fœtor and smears gave scanty Vincent's organisms. Two days later they were very numerous with marked fœtor. The blue line does not show too clearly in black and white though it was very well marked clinically. It may be seen at the gingival margin of 1 3 2 1. The papillæ are purple and hyperæmic and I suggest that there is a condition approaching hæmostasis. Ulceration is commencing between 1 3 2 and between 1 2 and has progressed to destruction of the mucoperiosteal bridge between the centrals.

The teeth are excellent and there appears to be no pre-existing focus. In the lower a similar condition is seen. The pocket, however, between 2 and 3 was deep and could not possibly have been produced since the onset of bismuth stomatitis.

It is likely that here was the source of the organisms which forty-eight hours later had infected the whole mouth.

I do not think that anyone has even tried to show that any one systemic factor is the sole cause of that lowering of tissue resistance which favours the onset of the condition. To do so would be to ignore those other factors that undoubtedly exert their influence.

There is abundant evidence that avitaminosis and debilitating conditions, alone or in association, have an important bearing on both the incidence and the duration of the disease, and I believe that functional disturbances are in this respect not to be overlooked.

A graph was kept of admissions to hospital over a full year which showed a peak period in April 1942, with a steady and sharp decline through the summer months, and a gradual rise through the autumn and winter. Admissions in March and April were 81% higher than the average for the whole year, and in June, July and August they were 29% lower. Total admissions were 173, 43 were tonsillar and oral together, the remainder were oral only. An interesting point was that in March and April patients remained in hospital on an average approximation 10% longer. This is not in conformity with other investigations of seasonal incidence, but the severity of the winter of 1941 and the lateness of the spring of 1942 may possibly have had some bearing, as regards both the dietetic and debilitating factors.

The debilitating effect of disease on the lowering of tissue resistance has been demonstrated by King (1943), who shows that even a common cold may precipitate an attack in the presence of infective material from an extraneous source, experimentally introduced into an artificially produced stagnation area. We should expect therefore that the incidence of the disease among hospitalized personnel would be greater than in other groups. Unfortunately it has not been possible to correlate the cases from the wards of the hospital with the total numbers, and with regard to oral sepsis. Among invalids, however, discharged as unfit for further naval service the incidence was 26% of 1,820. These included surgical, medical, and functional invalids and no distinction was made on examination. This incidence is higher than among new entries though the dental condition of the invalids was much better.

At various times I have had cases of some severity tested for ascorbic acid deficiency. Such tests gave deficiencies up to 7 mg. in twenty-four hours in 5 cases of 28. The work of McNee on naval ratings (1942) which correlates oral sepsis, vitamin C deficiency and gingivitis is of interest in this connexion.

The vitamin B<sub>2</sub> complex has also been shown to have a bearing on the lowering of oral tissue resistance, and the success achieved by nicotinic acid in some hands gives support to this as being one factor.

I have made some investigation into the possibility of endocrine hyperactivity and the redistribution of the blood in sympathicotomies subjected to war strain having a bearing on the incidence of the condition. Results at the moment are not very definite and the opinion of neuro-psychiatrists is not encouraging. I am, however, proceeding for I do not think that this possibility should be overlooked.

It would seem then that there are several systemic conditions which, by different means, can produce similar results, results which may have an important bearing on the onset of the disease in a mouth predisposed to its incidence. This is perhaps why we fail with general therapeutic measures, as exemplified by the proportional failure of ascorbic and nicotinic acid, unless every case is tested for specific vitamin deficiency, calcium-potassium, and acid-base balance, and vegetative, endocrine or functional disturbances, and the case treated on its merits. Fortunately such minute investigations are not necessary to effect a cure, and I maintain that whatever may be the systemic relationship, the disease does not occur unless there be an oral condition that predisposes to it. Nor will the disease recur when the mouth is rendered completely healthy.

Let me quote a single but by no means isolated case.

I inherited a patient in November 1941 who had had four recurrences in eighteen months. His mouth was well cared for but pyorrhoeic. He had been treated with chromic acid, or chromic acid and hydrogen peroxide on 48 different occasions and liquor arsenicalis on 14 others, and had 3 times been discharged as cured. Here surely was a case with a well-marked diathesis. He had a vitamin C deficiency of 5 mg. over twenty-four hours, and a salivary pH of 7.2. I treated him by local methods alone and he, without any correction of his systemic imbalance, returned to duty in nine days and remained

under my direct observation for fifteen months without recurrence. His pyorrhœtic condition, and consequent oral sepsis had for the time being at least been eliminated.

In such cases the treatment of pyorrhœa is intimately connected with the absolute cure of the fuso-spirochaetosis and in this respect the correction of the acid-base balance is essential (Broderick, 1928) and without it the pyorrhœa will progress and the syndrome recur.

### TREATMENT

The cure of the disease is swift and sure. I have aimed at two things in treating cases. First to reduce the time of sickness to a minimum and secondly to prevent recurrence. The method that I personally have found best to achieve these ends consists of the application of a zinc salt to the local lesions, the injection of arsenicals intravenously and the meticulous and if necessary drastic removal of all stagnation areas.

The peroxide of zinc is faintly soluble (1:40,000). It therefore ionizes but slowly, the zinc ions exercising a steady and continuous action by the precipitation of the proteins of the inflamed tissues, and the atomic oxygen released forming an environment unfavourable to anaerobic bacterial growth and to toxin formation. It is active against all anaerobic bacteria and the streptococcus, destroying or inactivating the hæmolysins of the latter. The *Staphylococcus aureus* is unaffected by it, and in view of its success in resolving gingival and oral ulceration, this may have an ætiological significance. It oxidizes bacterial metabolic products and is completely innocuous to human tissue (*Lancet*, 1942 (i), 418).

I have used it with very good results. I have also used it in association with mapharside powder and with sulphapyridine powder, but with no better results. Used as a 10% paste with soft paraffin it is spatulated with cotton-wool fibres into firm pledgets and these are packed hard into interstitial spaces, beneath mucoperiosteal flaps, into pyorrhœa pockets and other stagnation areas that will retain them. Composition caps are moulded around areas difficult of retention, filled with the paste and pressed home. Such caps, re-warmed, may receive the impression of the opposing teeth and are worn comfortably—even during meals. Cotton-wool rolls, impregnated, are laid in the buccal sulci and beneath the sides of the tongue, and napkins may be spread with the paste and laid against the palate. These can be folded back against ulcerated lips if necessary. Large ulcerated areas heal with remarkable celerity when so treated. The pledgets are changed daily and the rolls thrice daily—an intelligent patient may do the latter himself. After twenty-four hours the pockets are wide open and can be gently irrigated and a little preliminary scaling performed. Deeper scaling is done as the case progresses and finally necessary dental extractions and gingivectomy. All traumatized areas are kept packed and the eventual and generally rapid restoration of interstitial mucoperiosteal bridges and epithelialization awaited. The fact that no caustics are used increases the rapidity of healing.

Arsenic is injected intravenously on the first day and repeated as necessary on the fourth and ninth days. No toxicity has been noticed using mapharside or stabilarsen.

Time to cure (days)	Numbers of cases treated by each method		
	ZnO <sub>2</sub>	As	ZnO <sub>2</sub> + As
4—6	3		28
7—9	15		57
10—12	31		21
13—15	2	6	4
16—18	2		2
19—21			1
	53	8	113

Average time to cure: Zinc peroxide alone 10·08 days, Arsenic alone 13·88 days, Zinc peroxide + arsenic 8·18 days.

113 cases were treated by a combination of the two methods and averaged 8·18 days to cure. 8 cases treated by arsenic alone averaged 13·88 days. 53 cases treated by zinc peroxide alone averaged 10·08 days.

In two cases of great severity with marked toxæmia sulphapyridine was administered. These patients did very well and their temperatures dropped rapidly, but it was impossible to assess its effect on the local condition as I was treating the mouth by the foregoing means.

The systemic factors which bring about a lowering of oral tissue resistance may be said to be of academic interest only, since the dental surgeon can, by the elimination of oral

sepsis prevent the disease, and by local methods cure it. It is likely that the disease will continue until the biochemist produces the panacea for both pyorrhœa and dental caries and we are released from our labours.

I have to thank Lieutenant-Commander J. A. Fraser Roberts, R.N.V.R., for kind suggestions and checking of figures.

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McNEE, G. Z. L., and REID, J. (1942) *Lancet* (ii), 538.

Wing Commander H. M. G. Williams: Ulcerative gingivo-stomatitis or trench mouth has not so far proved a problem of any magnitude in the Royal Air Force; perhaps if it had the research that has only in recent months been commenced by F./Lt. Smart of the Medical Branch in collaboration with our dental officers, might have been started much earlier. F./Lt. Smart has examined a great many Royal Air Force personnel, choosing at random from all ranks and trades, and his figures so far show the incidence of general forms of gingivitis to be approximately 5%, and of Vincent's gingivitis less than 1%. The former figure is considerably lower than that shown in our returns of dental treatment.

In my opinion no matter what clinical signs present themselves at examinations the patient cannot be said to be suffering from true Vincent's gingivitis, or stomatitis, unless there are also general symptoms present. The patient must complain of a general malaise and will have a rise in temperature, however small. The clinical signs are well known and one is equally aware of the confusion between trench mouth in its milder forms and other forms of gingivitis.

I have spent a great deal of time lately in studying returns and working out calculations, and I am convinced that it is almost impossible to draw any conclusions about the epidemiology of ulcero-membranous stomatitis. All dental officers are not really sure what the true Vincent's syndrome is, and they have difficulty in differentiating this from more minor ailments. Secondly, until such a time as we can lay down *absolute diagnostic precepts about this disease*, their returns will continue to be unreliable.

The only way of arriving at a true statistical figure is for one team to make a series of examinations of many thousands of personnel over a long period, and this is now being done and the figures will be available in due course. It is therefore with some hesitation that I am giving you the following data. As you know, the R.A.F. Commands are not based on geographical areas, and so I can give no ideas based on incidence by districts. The incidence of general forms of gingivitis seems to be very much the same in Operational Commands as in Non-operational Commands, approximately 30 per 1,000 of population. In the Commands in which the operational flights are of long duration the incidence is slightly higher than in those in which the flights are of short duration. I can give no explanation of this because the aircrew personnel form such a very small percentage of the total population of such a Command. On the other hand the incidence of the Vincent's syndrome in the Non-operational Commands is higher compared with the rate for general gingivitis than in the Operational Commands; again with one exception. This is in Northern Ireland, where, although the rate of incidence of general forms of gingivitis is on a par with other Commands, the incidence of the Vincent's syndrome is on an average lower than in any other Command; in fact in six months out of the last twelve nil returns for Vincent's gingivitis have been made. One striking thing about the figures is that the incidence of general form of gingivitis remains remarkably steady, subject to the differences already noted, throughout the year; whereas the incidence of ulcero-membranous stomatitis pops about and you never quite know what is going to happen next, except that, as I have said, we have not had so far any serious outbreak—the highest incidence recorded being in January of last year, when in one Command the rate was 36 per 1,000 attending for treatment, or 7 per 1,000 population, although the annual rate for that Command is not greatly higher than others of the same type.

Analysis of all the figures I have studied suggests that the average incidence in the Royal Air Force of Vincent's gingivitis is about 1.5 per 1,000 population per month, or 18 per 1,000 per year.

Dr. J. D. Rolleston (Ex-President Section of Epidemiology and State Medicine): The epidemiology of trench mouth is closely associated with its history. The early accounts of the disease make it difficult to distinguish the fuso-spirillar infection from diphtheria, scurvy and other conditions. According to Professor De Lavergne, of the Val-de-Grâce Military Hospital, Paris, epidemic stomatitis was frequent in the wars of the French Revolution and the Empire when hospital gangrene was also prevalent. The earliest epidemic of the kind appears to have been that described by Desgenettes in 1793. Subsequent epidemics were that among the soldiers in La Vendée in 1818 mistaken for diphtheria by Bretonneau and that occurring during the Crimean war recorded by Bergeron in 1855. From 1855 to 1877 it was frequent among soldiers, sailors and children in hospitals and orphanages. From 1880 to 1914 it was much less frequent, and the fuso-spirillar infection chiefly occurred in a sporadic form, and its specificity which Vincent had claimed was not generally recognized at least in this country. During the World War of 1914-18, however, it became common under the name of "trench mouth". The literature of the subject during the war and the next few years I summarized in *The Medical Supplement of the Daily Review of the Foreign Press* issued by the War Office and its successor *Medical Science: Abstracts and Reviews* as well as in the chapter on Vincent's angina in my textbook on "Acute Infectious Diseases". Special mention may be made of the work of Major F. D. Bowman of Toronto of the Canadian Army Medical Corps, one of whose articles on the subject was published in the *Proceedings of the Section of Medicine of this Society* and was based on his observations made in Kent. Owing to the improper use of the term "Vincent's angina", which had been applied to the stomatitis as well as to the faucial lesion, Bowman suggested that the comprehensive term "Vincent's disease" should be employed for both conditions as well as for other localizations of the fuso-spirillar symbiosis.

Abroad the most notable epidemics of Vincent's disease were the malignant outbreak described by Heinemann and Sauerwald among Turkish soldiers in 1917 and that recorded by David and Hecht in the Roumanian army at Galatz when the disease was mistaken for scurvy.

#### *Epidemiological Details*

*Incidence.*—In my service as C.M.O. at the Grove Hospital (M.A.B.) during its military occupation from November 1916 to September 1919, when 2,499 officers and 13,459 of other ranks were under treatment, I did not see a single case either of trench mouth or of Vincent's angina. With these figures it is interesting to compare the following incidence of Vincent's angina at the Grove Hospital from 1905 when I first became familiar with the condition, to 1912 inclusive.

During this period 4,704 cases of diphtheria were admitted and another 809 cases were certified as diphtheria but were found after admission to have other forms of sore throat. Among the latter were 41 cases of Vincent's angina which therefore occurred in 0.7% of all cases of sore throat and in 5.05% of non-diphtheritic angina.

*Age.*—In peacetime the disease is rare in adults except in soldiers. In the 41 cases mentioned the only example of an adult was that of a policeman whose case I have reported elsewhere (1913).

*Sex.*—Males are much more frequently affected than females, unlike what happens in diphtheria in which females are most liable to be attacked.

*Geographical distribution.*—Vincent's disease has been found in all parts of the world.

*Contagiousness.*—Under peace conditions the contagiousness of Vincent's disease is slight. According to De Lavergne Vincent's attempt to inoculate himself was unsuccessful. Although cases have been recorded of the disease being conveyed by kissing or by the use of an infected pipe or glass as well as of infection of a dentist by his patient or of the patient by his dentist, I have never come across a case of Vincent's disease in a doctor or nurse.

*Diagnosis.*—Besides the clinical symptoms mentioned by previous speakers, I would allude to the existence of a positive Wassermann reaction apart from syphilis which has been recorded by several observers as well as by myself (1912) in a girl in whom it was positive in the acute stage and became negative in convalescence.

*Prognosis.*—Vincent's disease as a rule is a mild infection, but isolated examples of severe and even fatal cases have been recorded as well as malignant epidemics such as that I have already mentioned among Turkish soldiers. Many of the fatalities, however, were more probably examples of gangrenous angina than of the fuso-spirillar infection.

Owing to the possible co-existence of some grave blood disease, especially leukaemia or pernicious anemia, with Vincent's disease, it is advisable always to carry out a blood examination before making a prognosis. I have seen two cases of this kind, one of a girl, aged 5, who died of lymphatic leukaemia four months after recovering from Vincent's angina and the other in a woman whose death was due to pernicious anemia.

*Treatment.*—In the great majority of cases local application of tincture of iodine, as Vincent himself recommends, or of methylene-blue powder is sufficient. Cases which do not respond to such treatment can usually be cured, as in a case I recorded in 1913, by local application of salvarsan one to three times a day. In severe cases the salvarsan may be given intravenously.

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Surgeon Lieut.-Commander (D) R. L. Cautley, R.N.V.R.: (i) It was noticed that, during a period extending from the end of June to the end of October last year, there were practically no cases of ulcerative gingivitis. This is the season when fresh fruits and salad vegetables are most readily obtainable, which supports the theory that a vitamin deficiency is an underlying cause.

(ii) The successes claimed for intravenous injections of N.A.B. are not borne out by my own experience. Many of the worst cases seen during the past twelve months, were of men who had undergone or were undergoing courses of N.A.B. or mapharside injections for the treatment of syphilis. This method, however, has been found very helpful in these cases associated with parodontal disease which do not react to local treatment.

(iii) Treatment with 10% chromic acid plus  $H_2O_2$  (vol. 10) gives good results but recurrence is a possibility. The use of N.A.B. or mapharside powder applied direct to the gums on pledgets of cotton-wool and left for twenty to thirty minutes gives excellent and lasting results. Results of a further trial with dye solution were negative. A paste containing sulphanilamide starch, zinc oxide and glycerine is being tried. It is applied on cotton-wool pledgets which are left in situ until the next visit. Results are quite good, but it is too early to state whether it is any better than zinc oxide and oil of cloves paste.

(iv) The term "recurrence" should be avoided as in all probability the majority of so-called recurrences are more properly cases where, for one reason or another, the original treatment was not carried to a successful conclusion.

(v) Finally, the most important treatment of all is a thorough and careful scaling. Quite a number of mild cases can be cleared up by this treatment alone. Scaling should be carried out at the first or second visit, preferably the former.

## Section of Pathology

President—C. H. ANDREWES, M.D., F.R.S.

MEETING ON NOVEMBER 17, 1942, AT THE CHESTER BEATTY RESEARCH INSTITUTE,  
ROYAL CANCER HOSPITAL, LONDON

### DEMONSTRATIONS

C. Bonne : (1) *Sections of 8 Primary Cancers of Liver in Chinese and Javanese.*

Sections of eight primary cancers of the liver from Javanese and Chinese were exhibited on behalf of Professor Bonne of Batavia, Java; these showed the various histological types of such tumours and the Laennec type of cirrhosis which generally accompanies them.

G. M. Bonser : (2) *Tumours of the Bladder Produced by  $\beta$ -naphthylamine.*

A demonstration was made of the papillomatosis of the bladder epithelium which occurs when male or female dogs receive massive doses of pure  $\beta$ -naphthylamine by mouth over long periods. The epithelial changes range from simple hyperplasia to anaplastic carcinoma with infiltration of smooth muscle and permeation of lymphatic vessels, but without metastasis. The experiment shows that  $\beta$ -naphthylamine has carcinogenic properties apart from any impurities which may be present in the product in use in the dye industry.

H. Burrows, J. Iball and E. M. F. Roe : (3) *Electrical Changes in Wounds and Inflamed Tissues.*

Diagrams were displayed showing the increase in potential which occurs on injuring the skin in rats, when potential differences are measured between a superficial cut and earthed reference-points on the uninjured skin of the back. The wound-point is in nearly all cases positive with respect to the uninjured region when the direction of current in the external circuit is considered.

Similar results obtained with human wounds and abrasions were demonstrated by means of the valve microvoltmeter and non-polarizable electrode system used for this work.

H. Burrows, J. R. Clarkson and W. V. Mayneord : (4) *X-ray Tumours in Rabbits.*

When the occurrence of cancer in the hands of technicians and practitioners after repeated exposure to X-rays was first recognized, the question arose, almost at once, as to whether this sequel might follow a single dose of X radiation. Clinical observations in some particular instances suggested an affirmative answer, and experiments on rabbits by Lacassagne and Vincent proved the correctness of such an answer with this proviso that the tissues must be inflamed at the time of irradiation. We are now able to report



the outcome of additional experiments to elucidate the problem, using doses of X-ray within the range of those employed in human therapy. Our experiments were as follows:

Powdered silica was injected subcutaneously in the right groin in rabbits, and X-rays were applied one or two days later to an area of skin 4 cm. in diameter at the site of injection. To control the results, the same doses of X-rays were applied to identical areas of skin in other rabbits in which no previous injection of silica had been made. In yet other rabbits silica was injected without the subsequent application of X-rays. Of 18 rabbits in the first group (the radiation dose being 600 or 2,000 r), 13 developed sarcoma at the irradiated site. The control groups remained negative.

These results confirm those of Lacassagne and suggest that single moderate doses of X-ray caused neoplasia if the irradiated tissue was inflamed at the time of application, but not otherwise.

Photographs of the tumour-bearing rabbits were shown, demonstrating in every instance the presence of the primary tumour in the right groin, i.e. at the site of inflammation and subsequent X irradiation. Microscopic sections of the tumours also were shown.

J. W. Cook, C. L. Hewett, E. L. and N. M. Kennaway: (5) *Tumours of Liver Produced by 2:2'-Azonaphthalene and 2:2'-Diamino-1:1'-Dinaphthyl.*

2:2'-Azonaphthalene and its reduction product 2:2'-diamino-1:1'-dinaphthyl induce new growth of the liver, either of cholangiomatous or of hepatomatous type, in mice. This property shows a high degree of chemical specificity, since it is greatly diminished in the case of 1:1'-azonaphthalene, and 1:2'-azonaphthalene appears to be inactive. It is of interest that 3:4:5:6-dibenzcarbazole (into which 2:2'-azonaphthalene may be converted) produces similar changes in the liver, and is also capable of inducing sarcoma when injected subcutaneously, or epithelioma when painted on the skin.

L. A. Elson: (6) *Metabolism of Azo Compounds.*

A systematic study of the metabolism of azo compounds, a number of which produce tumours of the liver, is being made.

When azobenzene is fed to rats benzidine may be isolated from the urine after acidification. The colorimetric detection of this substance, and other metabolites containing amine groups, was demonstrated.

A. Haddow: (7) *The Inhibition of Growth by Chemical Compounds.*

The growth-inhibitory property characteristic of many carcinogenic compounds was demonstrated in its relation to normal growth and to the rate of growth of spontaneous and transplanted tumours (in mice and rats). A close degree of correspondence is often shown by the inhibitory and carcinogenic activity of nearly related compounds (as for instance in different series of derivatives of 1:2-benzanthracene). This relation is probably of causal significance, and other evidence was presented supporting the thesis that malignant alteration of the cell is an adaptive transformation arising in response to the peculiar interference with normal growth which the carcinogenic hydrocarbons produce. In particular, the cells of tumours induced by these chemical substances show a marked chemo-resistance to the inhibitory effects of the compound used for carcinogenesis. This fastness is not specific, and cross-resistance (to related carcinogenic compounds) was also shown. Such cross-resistance is, however, probably less intense than the resistance developed against the individual compound used for tumour induction. On the other hand, similar inhibitory activity has also been encountered in certain non-carcinogenic substances (for example, 1:2'-azonaphthalene). The growth-inhibitory effects of this compound were demonstrated, as also those due to various synthetic oestrogens. The latter compounds form a special class in this connexion, since, while not carcinogenic in the same sense as the cyclic hydrocarbons, some of them possess carcinogenic properties of a special character, the tumours they induce being in the main confined to tissues and organs of the reproductive and endocrine systems (especially the mamma, testis and anterior pituitary).

I. Hieger: (8) *A Carcinogenic Factor in Human Livers.*

The results obtained by Schabad and his collaborators have been confirmed. Sarcomas were produced at the site of injection of 18 mice (out of 467) by preparations, chiefly of

the unsaponifiable fraction, of human livers. Thirty-nine different preparations were used. At the tenth month when the first tumours appeared, the 8 positive series had 123 survivors. Thirteen of the tumours were produced by preparations from the livers of Europeans who had died of some form of cancer or sarcoma. The remaining 5 tumours were from preparations of livers of cancerous and non-cancerous South African Bantu who are very liable to primary cancer of the liver. The controls consisting of 160 mice injected with solvent alone (lard) were negative. Further investigations are in progress on human tissues other than liver.

E. L. and N. M. Kennaway : (9) *Multiple Tumours Produced by Carcinogenic Compounds.*

Multiple tumours, e.g. of the skin, stomach, lung, and ureter, have been obtained in mice treated with polycyclic compounds of certain classes (2-n-propyl-3:4-benzphenanthrene, 1:2:5:6-dibenzcarbazole, 1:2:5:6-dibenzacridine).

(10) *Graphs of Mortality from Cancer of the Lung, Larynx, Bladder and Prostate.*

Graphs, prepared from the data of the General Register Office, showed the mortality from cancer of the lung, larynx, bladder and prostate in England and Wales during the last thirty years and the standardized mortality rates for some of these. A great increase in deaths attributable to cancer of the lung, especially in males, is noteworthy and the question presents itself whether this represents any actual increase, or is wholly the result of more accurate diagnosis.

J. H. Mulvany : (11) *Specimens Illustrating (a) the Distinction Between Thyrotoxic and Thyrotrophic Exophthalmos; (b) New Classification of Hyperthyroidism.*

Dr. Mulvany provided specimens showing the distinction between thyrotoxic and thyrotrophic exophthalmos.

L. R. Woodhouse Price : (12) *Pathological Specimens and Lantern Slides.*

The following exhibits were on view:

(a) A series of lantern slides illustrating the pathology of melanoma. These included examples of the normal distribution of melanin in the skin and uveal tract; examples of primary and metastatic melanomata of both melanotic and achromic types; and especial reference was made to the relative distribution and morphological characters of melanin pigment in melanoblasts and in chromatophores.

(b) A series of lantern slides illustrating the effects of advanced untreated carcinoma. Examples shown included primary carcinoma of the penis; several examples of primary carcinoma of the lips, alveolar margin and buccal mucosa, producing pathological fractures of the mandible; advanced basal-celled carcinoma resulting in panophthalmitis and meningitis; advanced carcinoma of the bowel, and other cases. A pair of slides was shown illustrating the value of differential light filtration to accentuate the cell nuclei and stroma respectively—a method particularly useful for the histological diagnosis of sarcoma.

(c) A series of lantern slides illustrating metastatic deposits of carcinoma. Especial reference was made to the widespread dissemination from a primary source of squamous carcinoma, and from early central colliquative necrosis resulting in cyst formation. Schmidt's phenomenon of resorption of minute, early metastatic deposits in liver and lung was also illustrated.

(d) A series of photomicrographs in colour, illustrating various neoplastic diseases, prepared in the Pathology Department by the Dufaycolor process.

(e) A series of museum specimens of rare or unusual tumours, comprising the following:

- (1) Benign calcified epithelioma. (2) A feminizing carcinoma of the suprarenal cortex.
- (3) Carcinoid tumour of appendix. (4) Mixed tumour of cervix uteri. (5) Polycystic liver. (6) Recurrent salivary gland tumour. (7) Osteogenic sarcoma of mandible.
- (8) Interstitial-celled testicular tumour. (9) Sacro-coccygeal chordoma. (10) Carotid body tumour. (11) Early carcinoma of thyroid. (12) Lingual thyroid. (13) Umbilical endometrioma. (14) Sarcoma of urinary bladder.

F. L. Warren : (13) *Oxidation of Hydrocarbons in Presence of Ascorbic Acid.*

Ascorbic acid (vitamin C) in the presence of oxygen oxidizes aromatic hydrocarbons in aqueous acetone solution. The oxidation is analogous with that which occurs with some hydrocarbons in the presence of other easily autoxidizable substances. The initial stage of the reaction appears to be the introduction of an oxygen atom at one of the main centres of reactivity of the hydrocarbon. The phenol thus formed is subsequently oxidized to a quinone. Thus anthracene is converted to anthraquinone and 3:4-benzpyrene yields a mixture of the two monoquinones. The ascorbic acid oxidation products of the hydrocarbons are in some cases the same as those formed from them metabolically in animals. As an example of this, the conversion of the carcinogenic hydrocarbon 3:4-benzpyrene to a mixture of the two benzpyrene monoquinones (5:8- and 5:10-) was demonstrated.

(14) *Adrenal Tumours.*

Results of colorimetric determinations of total urinary 17-ketosteroids in 40 cases were shown. Male and female urines from patients showing clinical signs of a variety of endocrine disorders were examined. The majority were from female patients exhibiting virilism or hirsutism and the series included four cases of carcinoma of the adrenal cortex. In these four cases the excretion of 17-ketosteroids exceeded 100 mg. per day. In one case of benign hyperplasia of the adrenal cortex in a young girl excretion approaching 100 mg. per day was found but the excess androgen was identified as androsterone whereas dehydroandrosterone is usually the excess androgen in malignant hyperplasia.

(15) *Tumours Produced by 9:10-dimethylantracene.*

Specimens of malignant tumours of the skin produced in mice by the application of 9:10-dimethylantracene were shown. This hydrocarbon is one of the simplest carcinogenic compounds yet discovered. No connective-tissue tumours were obtained in experiments in which this compound was administered by subcutaneous injection.

## Section of Medicine

President—GEOFFREY MARSHALL, O.B.E., M.D.

[May 25, 1943]

### Peritoneoscopy

R. Milnes Walker, M.S.

ONE of the essential requisites for a peritoneoscopy is the induction of an artificial pneumoperitoneum, just as in thoracoscopy a pneumothorax is required, and it is of interest to note that it is precisely half a century since reports of the clinical induction of a pneumoperitoneum were first published. It is, in fact, nearly as long as that since attempts at endoscopic examination of the peritoneal cavity were first made, but only during very recent years has the method become safe and of real value, its uses and limitations being at the same time accurately defined.

The first attempts at visual examination of the peritoneal cavity without a large incision were reported in 1901 by Ott in Russia, who used a speculum and head mirror. Kelling of Dresden was apparently the first to attempt such a procedure with an instrument which carried its own source of illumination, viz. the Nitze cystoscope, then a new invention. He employed a pneumoperitoneum, but his work at that time was only experimental and carried out on dogs; this was reported in 1901. Nine years later he described its use in two human patients, and again after the last war he wrote favourably on the subject. Jacobaeus, the pioneer of thoracoscopy, was probably the first to employ this type of instrument in the human patient, for he reported, in the same year as Kelling, three cases, all of whom had ascites, which he examined in this way. Very little came of this early work, but a few sporadic attempts were made to revive the method during the next twenty-five years, in most cases a cystoscope being the instrument employed.

It was not until Ruddock of Los Angeles some ten years ago devised a special instrument for the purpose that further progress was made and the safety of the procedure satisfactorily demonstrated. There has been little change since Ruddock wrote a full account in 1937, though the extent to which it has come into prominence is shown by the fact that there have appeared to my knowledge over sixty papers dealing with the subject in the medical literature since that date.

The examination is usually carried out under a local anaesthetic, but if there is a strong probability that it will be desirable to follow it up with an open operation, a general or spinal anaesthetic may be employed. In my own series 80% of cases have been undertaken under a local anaesthetic, but for gynaecological purposes a general anaesthetic is usually necessary, as patients will not tolerate the high Trendelenburg position required to obtain a view of the pelvic organs. It causes very little disturbance to the patient, who, unless detained for other reasons, is as a rule able to leave hospital

on the following day. After the induction of a pneumoperitoneum, a cannula is inserted through a stab wound in the anterior abdominal wall, and a telescope, with a field of vision directed obliquely forward and carrying a source of illumination, passed through the cannula, strictly aseptic precautions being, of course, observed.

I would like to emphasize the safety of the method as at present employed. In a recent review of the subject in America, among 2,000 patients on whom it has been carried out, there have been two deaths reported, one from hemorrhage from the liver from an area where a biopsy specimen had been taken, the bleeding being inadequately controlled, the other in a very feeble, moribund patient who was an unsuitable case. In our own series, we have had no deaths which can be attributed to the investigation. We have encountered no instance of injury to the intestine; in the collected 2,000 cases already referred to this complication occurred eleven times, the injury being caused sometimes by the pneumoperitoneum needle, sometimes by the trocar of the peritoneoscope; all these patients had adhesions to the abdominal wall: where the injury was small it was left to close spontaneously, but in other cases repair was carried out: no deaths resulted. A little surgical emphysema round the stab wound is a common sequel and of no consequence; we have never seen any herniation through the puncture in the abdominal wall nor any signs suggestive of air embolism, though it is not infrequent to see small bubbles of air in the substance of the great omentum while the examination is being made.

The use of the peritoneoscope is limited, and proper selection of cases for investigation is the secret of success; it must be considered as only one link, but often the last link, in the chain of evidence which goes to make a complete diagnosis. It is now five years since I first made use of it, and up to now I have only employed it some 135 times. During this period my colleague in the department of gynaecology, Mr. Lyon Playfair, has used it a similar number of times, and he has kindly permitted me to draw on his experience in formulating these remarks; these cases include some in the early part of the series which we now know were unsuitable, therefore we find it of value in only quite a small proportion of the abdominal cases coming under our care. However, it has spared many patients a useless exploratory operation.

The organs which can be seen with the instrument are those which would become exposed if the whole of the anterior abdominal wall, together with the ribs and costal cartilages which overlie the upper part of the abdominal cavity, were to be removed: in addition the whole of the peritoneal surface of the anterior abdominal wall is open to inspection, together with the falciform ligament. By altering the position of the patient the pelvic organs in the female can usually be brought into view; gentle manipulation of the tip of the telescope allows the left lobe of the liver to be raised to examine most or all of the anterior surface of the stomach, and in a proportion of patients similar raising of the cæcum will expose an otherwise covered appendix. In the same way raising the right lobe of the liver may reveal a gall-bladder whose fundus does not project as far as the liver edge; the tip of the spleen can often be brought into view, particularly in cases of splenomegaly, but examination of the small and large intestines is apt to be unsatisfactory as they are in part covered by the great omentum.

There are two factors which may seriously limit the scope of the examination in individual patients. The first is adhesions; these may be so generalized as to prevent the examination completely, as in some cases of tubercular peritonitis, or they may obscure some part only, as in the case of adhesions to the back of a previous operation scar; in other cases the finding of adhesions may be a point of valuable diagnostic assistance. The second limiting factor is adiposity; it is not so easy to manipulate the instrument through a fat abdominal wall, while a bulky great omentum may completely obscure the view, and in a few instances, try as I would, I have been unable to move it from the part of the abdominal cavity that I wished to examine.

In my experience the largest group of cases where it has proved of value is that of carcinoma or suspected carcinoma of the stomach. In this series there were 49 cases; in 18 of these a definite diagnosis had been already made but peritoneoscopy was required to determine the presence or absence of metastases; in 31 the diagnosis was in doubt. Taking both groups together the diagnosis was confirmed in 37 either by visualization of the primary growth or of metastases, but of course in the remaining cases a carcinoma could not be excluded as the growth may not involve the visible part of the

stomach wall, or may be yet confined to its inner layers. In some of these cases another condition which accounted for the symptoms was found at peritoneoscopy, others were subsequently submitted to operation, when it was found that 2 of these 12 cases actually had a carcinoma. In the 37 cases in which the diagnosis was confirmed, definite metastases were found in 18, and therefore these cases were spared a useless exploration; of the 19 cases considered operable after peritoneoscopy, 10 subsequently underwent a partial or total gastrectomy, while the remainder were found at operation to be irremovable on account of an extension of the growth which had not been seen, usually an invasion of the pancreas or of the lumbar lymph nodes. I would emphasize that cases of early gastric carcinoma definitely diagnosed by radiology or by gastroscopy have not been submitted to peritoneoscopy, nor have those with obvious metastases detected clinically. Thus suspected or definite carcinoma of the stomach is an indication for peritoneoscopy to establish the diagnosis or to settle the question of operability, and something like one out of every three of these cases will be spared a useless operation.

The second large group is a miscellaneous one in which I have placed together unexplained ascites, unexplained enlargement of the liver, and unexplained persistent jaundice. In this group are 34 cases, of which 13 were proved to have metastatic carcinoma of the liver, 3 had malignant peritonitis, and 2 had both these conditions. 7 cases were shown to be due to cirrhosis of the liver, 4 showed other liver changes in colour or surface texture suggesting fatty degeneration or hepatitis and 1 was a case of amyloid disease of the liver, not recognized at the time, because we had not then had at our disposal satisfactory means of taking biopsy specimens such as have since been developed. Of 3 other cases of jaundice, no abnormality was detected in 1, which was diagnosed as catarrhal jaundice; in the second a primary carcinoma of the gall-bladder was seen, while the third, from the appearance of the gall-bladder, was diagnosed as due to a stone in the common bile duct, but the case subsequently cleared up, the patient refusing operation. Thus ascites of uncertain origin is a very definite indication for peritoneoscopy, which is no more severe an operation than paracentesis and gives a great deal more information. Unexplained enlargement of the liver is also an indication in which the investigation will usually settle the diagnosis, while it will often betray the cause, not otherwise demonstrable, of persistent jaundice.

Another indication is suspected tubercular peritonitis; of 7 cases in which a tentative diagnosis had been made, 3 showed actual miliary tubercles, while in 2 no pneumoperitoneum could be established on account of adhesions. Of these cases, 1 was explored and the diagnosis confirmed, in the other the presence of adhesions together with the clinical findings was judged adequate to establish the diagnosis. In the other 2 the examination was made to exclude this condition, 1 proving to be anorexia nervosa, and the other appendicitis, the adherent organ being seen through the peritoneoscope.

It is of value in the diagnosis of lesions of the pelvic organs, particularly of the fallopian tubes and ovaries, and it is especially valuable in the diagnosis of ectopic pregnancy. I have noted cases of ovarian cyst, hydrosalpinx, pyosalpinx and hæmorrhage from a graafian follicle; this latter condition is very apt to be diagnosed as appendicitis, but peritoneoscopy will distinguish between them.

The diagnosis of cholecystitis or gall-stones by peritoneoscopy is not reliable, and other methods are more accurate; these patients are often fat, but if in a thin patient it is not possible to get a view of the gall-bladder through the telescope, there is a strong probability that the organ is shrunken and inflamed; on the contrary we all know that a gall-bladder containing stones may appear quite normal from the exterior.

It is sometimes difficult to be sure if a tumour in the left hypochondrium is an enlarged spleen, or arising from the stomach or colon; peritoneoscopy will usually settle this question, as in most cases the tip of a normal spleen comes into view when the patient turns on to the right side, and an enlarged spleen is always visible unless it is covered by adhesions; however, it is of no value in the differentiation of the various causes of splenomegaly.

Peptic ulcers often occur on the posterior surface of the stomach or duodenum, and, even if on the anterior wall, may not cause changes on the peritoneal surface, so that peritoneoscopy cannot be relied on in this condition. It may be helpful in carcinoma of the colon or rectum, in determining the presence of hepatic or peritoneal metastases,

when there is no call for a palliative operation. The method has been used to detect whether wounds of the anterior abdominal wall have penetrated the peritoneal cavity, and it is also employed in doubtful cases of intraperitoneal hæmorrhage of traumatic origin. Occasionally help is obtained in the diagnosis of intra-abdominal tumours of uncertain origin; as an example of this I quote a case of a retroperitoneal melanotic metastasis, recognized with this instrument, in a man whose eye containing the primary tumour had been removed three years previously.

It has been stated that the peritoneoscope should not be used in acute abdominal illnesses for fear of spreading infection; this is not likely to occur during the early stages, and I should not hesitate to use it if it seemed advisable during the first twenty-four hours of an attack, to distinguish, for example, acute appendicitis from acute salpingitis or a ruptured ovarian follicle.

Certain operative procedures can be undertaken through the peritoneoscope. The only one of which I have experience is the taking of specimens for biopsy purposes, and it has proved most satisfactory as regards the liver: the hæmorrhage is controlled by means of a coagulating diathermy current; specimens may also be taken from the omentum or solid tumours, but the spleen owing to its vascularity is unsuitable for biopsy by this method, and, of course, the hollow viscera must be avoided. In order to obtain a specimen of satisfactory size, I insert the forceps through a second cannula, and the operation can then be carried out under good vision. Mr. Playfair has undertaken sterilization in the female successfully by fulguration of the fallopian tubes, and there is promise that on more experience this may prove a practicable method.

There are two further points to which I should like to refer; one is the amount of air employed in the pneumoperitoneum. When we have taken readings of this, between two and three litres have been necessary; it is surprising how little disturbance is caused in the conscious patient by the rapid injection or withdrawal of this quantity of air; the intra-abdominal pressure rises to about 8 cm. of water on inspiration and 18 cm. of water on expiration, but goes much higher if the patient strains or coughs. The second point is the medium used; air has proved most satisfactory, but I have induced a hydro-peritoneum with two litres of saline in order to make an attempt at visualizing structures deeper down in the abdomen, though so far have not had much success. It may, however, lead to a widening of the scope of the examination.

Peritoneoscopy opens up further opportunities for investigation of the difficult subject of visceral pain; the technique in the conscious patient is so simple, and a co-operative patient may assist in giving valuable information; at the present time it is to be noted that gentle stroking of the parietal peritoneum with the smooth instrument is not felt by the patient, whereas pressure over the same area produces a painful sensation. The patient is not aware when gentle manipulation of the viscera is being carried out, and coagulation of the liver, as is done in the taking of biopsy specimens, causes no conscious sensation whatever.

In the first few examinations one cannot expect to recognize and interpret correctly all that is seen; the method should be persevered with until one is quite familiar with the normal appearances. With selected cases the method has a definite value in the diagnosis of certain types of abdominal disease; not only is it safe, but it will spare a considerable number of patients the necessity of an open operation.

#### A. M. Cooke, D.M.

SINCE the introduction of laparoscopy or peritoneoscopy by Ott (1901) and Kelling (1902), the method has made slow progress in Europe, mostly in Germany and Sweden. The first American paper appeared in 1911, and little other work was done there until Ruddock's papers in 1934 and 1937 revived interest in the subject. Progress in the United States of America, when it began, was rapid; in 1935 there were only two or three peritoneoscopes in the country, but by 1941 over 300 were in use. The British literature contains six references to peritoneoscopy, only one of which is of any consequence—a paper by Walker and Playfair (1942) reporting a series of 125 cases.

Robinson and Fiske (1941) stated that 7,000 peritoneoscopies had been done, but I have collected from the literature mention of only 3,328 examinations, reported by 34 authors. Six deaths occurred in the series, but not all could be attributed to peritoneoscopy. Ruddock

(Robinson and Fiske, 1941) has the largest single series of 1,500 examinations with only one death. Kalk had by 1935 a series of 350 peritoneoscopies with no deaths. Six other authors have reported series of 100 cases or over, with five deaths. The technique, of which details need not concern us here, consists essentially of the removal of ascitic fluid if this be present, induction of a pneumoperitoneum, and inspection of such viscera as are visible. In the majority of patients it is possible to inspect the anterior aspects of the liver and stomach, the anterior parietal peritoneum, the omentum, parts of the small intestine, and the superior aspects of the pelvic organs in female patients. It is sometimes possible to see the gall-bladder, parts of the large intestine, the appendix, hernial orifices, and the spleen when enlarged. Various ancillary methods have been devised to extend the usefulness of peritoneoscopy, in particular the taking of biopsies from solid viscera. Anderson (1937) has transilluminated the stomach, colon, bladder, and vagina during the examination, and has also severed intra-abdominal adhesions with a bistoury passed through another cannula. Beling (1939) and Horan and Eddy (1941) have taken photographs through the peritoneoscope.

Ruddock (1939) has identified through the peritoneoscope no less than 54 different pathological conditions. My own experience has been limited to 34 cases, with no mortality or morbidity. Valuable diagnostic information was obtained in 32 instances. Conditions identified included cirrhosis of the liver, peritoneal metastases, hepatic metastases, chronic passive congestion of the viscera, carcinoma of the stomach, gastric ulcer, carcinoma of the gall-bladder, ovarian tumour, retroperitoneal tumour, and tuberculous peritonitis. From the point of view of the general physician peritoneoscopy is employed, if the diagnosis is not reasonably certain by other means, in cases of ascites, suspected hepatic cirrhosis, carcinoma of the alimentary tract, abdominal tumours, and tuberculous peritonitis (if shifting dullness be present). Cirrhosis of the liver may be suspected on clinical grounds, but the diagnosis can be made with certainty only by direct inspection of the liver; for this purpose peritoneoscopy has everything to recommend it as against laparotomy. I have found cirrhosis in patients when there was nothing in the history or physical examination pointing to this diagnosis, and conversely have demonstrated its absence in cases where it was presumed on clinical grounds to be present. In carcinoma of the alimentary tract, if peritoneoscopy reveals metastases in liver, peritoneum, or omentum, the patient can be spared a useless laparotomy. There is also the saving in time, energy, and expense by the simpler procedure. Ruddock, with his unique experience, has accomplished the purpose for which the examination was done in 1,473 cases out of 1,500, and has obtained an accuracy of diagnosis by the peritoneoscope of 94% as against a figure of 61% in the same series of patients by all other means.

The dangers are few and can mostly be avoided by careful selection of cases and adequate technique. With care, hæmorrhage and sepsis need not occur, and surgical emphysema of the abdominal wall is not of serious import. The only danger which may occur despite every reasonable precaution is puncture of the viscera. In 900 examinations by Ruddock this accident occurred 8 times (small intestine 4, large intestine 2, stomach 2), but in no case did any serious consequences follow. With pre-operative preparation by morphia and careful local anaesthesia, the procedure is painless, unless the electric lamp of the peritoneoscope touches the parietal peritoneum. My own patients who have been examined by peritoneoscopy and gastroscopy have been unanimous in saying that the former is the less unpleasant procedure. Peritoneoscopy is contra-indicated in patients with acute abdominal conditions, intestinal obstruction or intestinal distension from any cause, multiple peritoneal adhesions, and excessive obesity.

With proper selection of cases, careful technique, and an adequate acquaintance with the pathological appearances likely to be encountered, peritoneoscopy is a simple, safe and valuable diagnostic procedure.

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## P. Lyon Playfair, F.R.C.S.

Mr. Playfair preferred to refer to this method of investigation as peritoneoscopy rather than laparoscopy, as the former seemed to him to be the more descriptive term.

He had now done 140 peritoneoscopies and although most of these had been in gynæcological cases, the general principles of the examination were very similar to those in medical and surgical ones. As the peritoneoscopy was mainly used to assist in diagnosis, in estimating its value the following points should be considered: (1) The type of case in which it is likely to give most help. (2) The degree of accuracy of the diagnosis made with it. (3) The safety of the operation. (4) The amount of the patient's time taken in the investigation.

He quite agreed with what had been said about the most suitable groups of cases for this type of investigation, but wished to stress the point that peritoneoscopy was not a method which could be used for the diagnosis of all abdominal lesions, but that its use was confined to lesions of the organs already indicated in the previous papers.

*Accuracy of diagnosis.*—He had found it usually possible to make a diagnosis by observation only, but when any doubt existed he took a biopsy through the instrument, and this was done in 10 cases. In the 140 cases he had now examined, the peritoneoscopic diagnosis had been checked by subsequent laparotomy or autopsy in 54 cases, the diagnosis being proved accurate in 50 and wrong in 4, making a percentage of 92.6%. This was encouraging as these cases were all ones in which the diagnosis was still in doubt after the usual clinical investigation had been carried out.

The instrument was of most value in the diagnosis of malignant metastases; in estimating the operability of malignant pelvic conditions; in the diagnosis of various conditions of the tubes and ovaries, particularly in ectopic gestation, in tubercular disease and to a less extent in the differential diagnosis between acute right-sided salpingitis and appendicitis.

*Safety of peritoneoscopy.*—There had been no mortality in the 140 cases, nor had he had any serious complications.

*The time spent in hospital* was on an average between twenty-four and thirty hours after the operation, and the majority of patients were able to resume their occupations in two or three days.

The technique in examining gynæcological cases was very similar to any other case, but he found that some patients could not bear the high Trendelenburg position very well without general anaesthesia, and for this reason about 50% of his cases had had a general anaesthetic, usually gas and oxygen or intravenous sodium pentothal.

Therapeutically the instrument had been used for a number of conditions, but he had only used it for sterilization by cautery and excision of part of the fallopian tubes and although these proved satisfactory as shown by subsequent salpingographies, he had not done enough of these to give a definite personal opinion upon them.

## CONCLUSION

Dr. Playfair thought the peritoneoscope to be of value in the diagnosis of selected groups of cases, and that satisfactory biopsies could be taken with it. Peritoneoscopy was a safe procedure and might prove a useful method of sterilization and observation of the progress of abdominal and pelvic disease and possibly of the effects of drugs and treatment upon the pelvic and abdominal organs.

## An Outline of Bronchial Anatomy

By A. F. FOSTER-CARTER, D.M.

As long ago as the seventeenth century anatomists were preparing casts of the pulmonary air passages by filling the bronchi with fusible metal and removing the lung tissue by corrosion. These early anatomists were chiefly interested in the nature of the cellular structure of the lung, the distribution and mode of branching of the larger bronchi had no importance for them and were not studied in detail until the latter part of the nineteenth century. Indeed some modern textbooks of anatomy still reproduce archaic and inaccurate woodcuts illustrating the trachea and its main branches. Aebly in 1882 was the first to give a detailed description of the human bronchial tree and this was followed in 1889 by the even more minute account of William Ewart, who was physician and pathologist to the Hospital for Consumption, Brompton. Ewart went so far as to name the bronchi down to those of the sixth order and his description was based largely on the study of solid casts of both the bronchi and the pulmonary blood-vessels which he made with fusible metal. But, as so often happens, the work of Aebly and Ewart was forgotten and it was not until little more than ten years ago that interest in the bronchial tree revived. This revival was due to the development of chest radiography, particularly bronchography, and also to the increasing use of bronchoscopy and the advance of thoracic surgery. In 1932 Kramer and Glass pointed out that the lung could be subdivided into a number of segments, each supplied by a well-defined bronchus having an orifice which was visible on bronchoscopy. But perhaps the best known contribution to the subject is a brief description of the bronchial tree, with diagrams, published by H. P. Nelson in 1934 and often reproduced subsequently. Nelson himself stated that this account was incomplete and was not final but unfortunately the full publication of his anatomical researches was prevented by his tragic death.

The following description of the bronchi in man is based on an investigation which started with an attempt to make corrosion casts of the bronchial tree using celloidin instead of fusible metal. Details of this method have already been published (Foster-Carter, 1942). A study of these casts brought to light certain points which were at variance with previous accounts and a further investigation of dissections and bronchograms was therefore undertaken in order to supply the omissions and clarify the obscurities of former descriptions.

Fundamentally the bronchial system in each lung consists of a stem with a series of dorsal and ventral branches. Each pulmonary artery, arising in the gap between the two main bronchi, must cross the stem bronchus to reach the lung. In the reptiles the first branch bronchi arise from the stem below the point at which it is crossed by the pulmonary artery, but in most mammals a branch develops above this point on the right side. This is the eparterial bronchus and it supplies the right upper lobe. The mammalian left lung still resembles that of the reptiles because the first branch of the left stem bronchus, supplying the upper lobe, arises below the left pulmonary artery.

Let us consider first the bronchi of the right upper lobe (fig. 1). The eparterial bronchus divides into three branches, posterolateral or dorsal, anterolateral or ventral and apical. Many previous accounts have mentioned a fourth or "axillary" branch but this does not normally exist in the human lung. The axillary area of the right upper lobe is supplied by lateral twigs from the anterior, posterior and apical branches and not by a separate "axillary" branch. Continuing down the right stem bronchus, the next branch, the middle bronchus, is directed forwards and supplies the middle lobe; it has two main divisions, anterior and lateral.

In the left lung the branch to the upper lobe arises below the pulmonary artery and combines the functions of the eparterial and middle bronchi on the right. The left upper lobe is equivalent to the right upper and middle lobes and is rarely subdivided by a fissure. The bronchus to the left upper lobe therefore has, as would be expected, two main divisions; the left ascending bronchus and the left middle bronchus. The ascending branch is equivalent to the eparterial bronchus on the right and has similar branches—anterolateral, apical and posterolateral—the last two arising by a common stem. The left middle bronchus supplies that area of the left upper lobe which corresponds with the right middle lobe, sometimes called the lingula or lingual process; it has anterior and lateral divisions as on the right side.

The bronchi of the lower lobes are similar on the two sides and may be considered together. Continuing our journey down the stem bronchus—after it enters the lower lobe the first branch to be encountered is a large bronchus directed backwards. This is the first dorsal branch of the stem and it supplies the apex of the lower lobe. Branches of this bronchus can also extend as far outwards as the posterior axillary line and downwards to the level of the 10th dorsal vertebra. The next branch, the cardiac bronchus, is peculiar to the right lung, it arises from the medial aspect of the stem and supplies the medial part of the right lower lobe adjacent to the heart. A short distance farther down, another large branch, the anterior basic, arises from the anterior aspect of the stem to supply the anterior part of the lower lobe. Almost immediately after this the stem bronchus appears to bifurcate into two terminal branches, the middle basic and

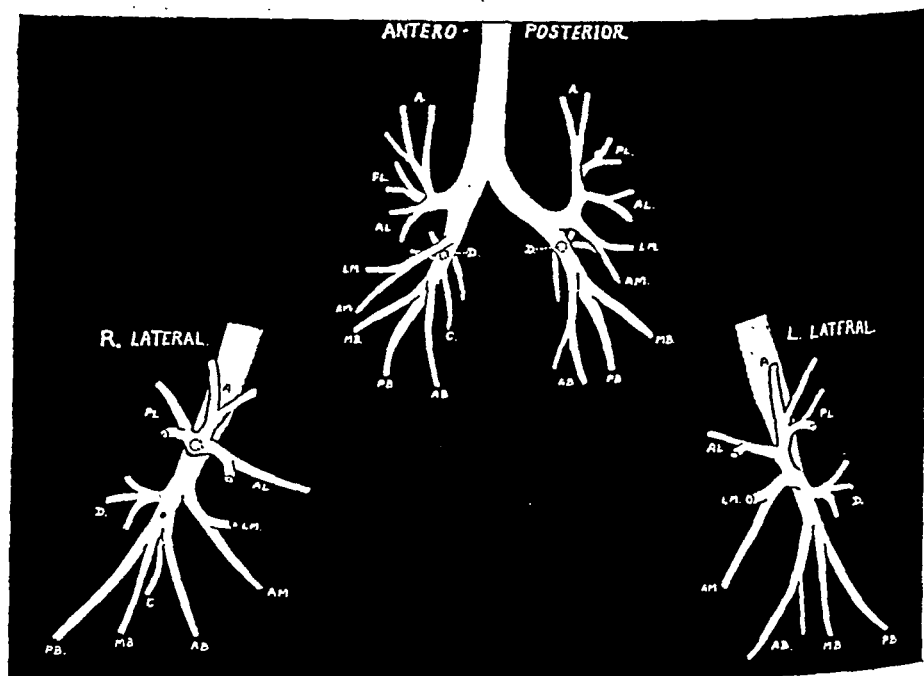


FIG. 1.—Schematic diagram of the human bronchial tree

A. Apical. AL. Anterolateral. PL. Posterolateral. AM. Anterior middle. LM. Lateral middle. D. Dorsal. C. Cardiac. AB. Anterior basic. MB. Middle basic. PB. Posterior basic.

the posterior basic. These supply the middle and posterior parts of the lower lobe respectively and the posterior basic branch is actually the direct continuation of the stem bronchus itself.

A knowledge of bronchial anatomy can be applied in many ways. It is essential for the proper production and interpretation of bronchograms. To produce a good bronchogram it is best to fill only one lung at a time and while the iodized oil is being injected, the patient should be placed in a series of carefully planned positions in order that all the bronchi of the lung may be filled. In the semi-recumbent position the oil flows into the posterior parts of the lower lobe (fig. 2). With the patient leaning forward the middle and anterior parts of the lower lobe and, on the right side, the middle lobe are filled (fig. 3). The patient then lies on his side and the oil fills the upper lobe (fig. 4); rolling on to the face and on to the back at this stage helps to distribute the oil throughout the lung. It must be remembered that the bronchial tree is a three-dimensional object and in order to depict any three-dimensional object in two dimensions it is best to show two views of it, taken at right angles to each other. For this reason the antero-



FIG. 2.—First position for bronchography of the right lung.



FIG. 3.—Second position.



FIG. 4.—Third position.

posterior view alone is of little value in interpreting a bronchogram; only when it is viewed together with a lateral film can each bronchus be identified with certainty. If, by design or accident, the bronchi of both lungs have been outlined at the same time, the lateral film becomes confused owing to superimposition and an oblique film is necessary to separate the bronchi of the two sides. Such separation occurs when the chest is at an angle of 45 degrees to the X-ray plate, but the resulting picture is rather more difficult to interpret than the lateral view.

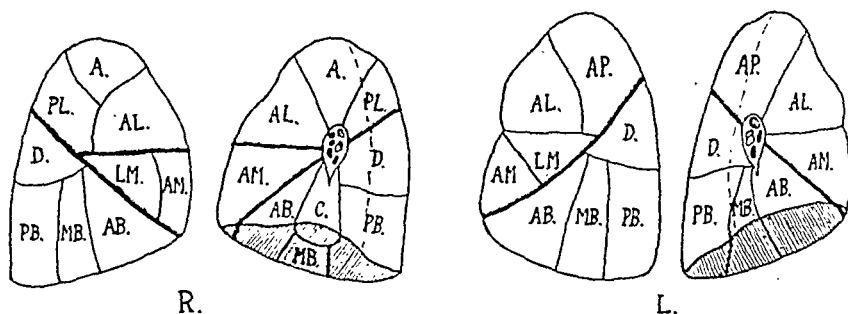


FIG. 5.—The bronchopulmonary segments.

A. Apical. AL. Anterolateral. PL. Posterolateral. AM. Anterior middle. LM. Lateral middle. D. Dorsal. C. Cardiac. AB. Anterior basic. MB. Middle basic. PB. Posterior basic. AP. Apico-posterior (combined left apical and posterolateral segments).

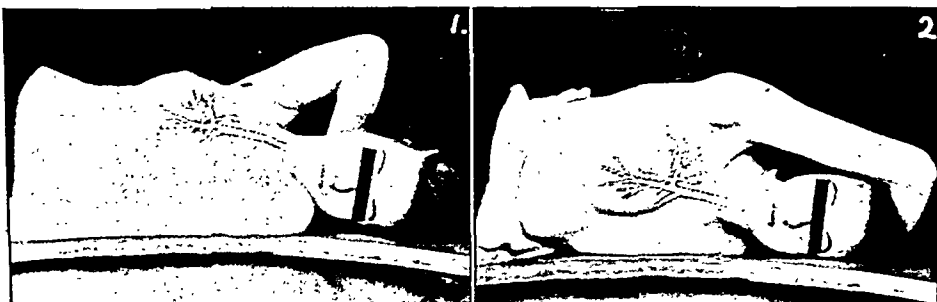
Finally, a knowledge of the anatomy of the bronchi brings with it a new clinico-anatomical conception of the lung as a functional organ composed not merely of lobes but of a number of smaller yet distinct segments each supplied by a well-defined bronchus. The areas of lung supplied by the bronchial divisions which we have described are shown in fig. 5; the sizes of the segments relative to each other vary slightly in different lungs. Disease processes, especially those caused by aspiration such as lung abscesses, are often confined to one or more broncho-pulmonary segments and an understanding of these subdivisions is of great value both in elucidating the X-rays of such conditions and in planning their treatment. For instance, if it is decided to treat an infective lesion in the lung by postural drainage it is necessary first to decide from the X-ray which segments are involved and then to plan the optimum position for drainage from a knowledge of the course of the bronchi draining these segments (figs. 5, 6, 7 and 8).

In this brief account of normal bronchial anatomy, variations have purposely been omitted for the sake of clarity. Certain important variations do occur and they are described elsewhere (Foster-Carter, 1942), but the very word variation presupposes the existence of a normal arrangement and the basic mode of branching of the bronchi is the same in the large majority of instances. It is this common pattern, the theme upon which any variations must be based, which I have endeavoured to describe.

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FIGS. 6, 7 and 8.—POSITIONS FOR POSTURAL DRAINAGE OF THE VARIOUS PULMONARY SEGMENTS.



(1) Anterolateral (right upper lobe).

(2) Posterolateral (right upper lobe).

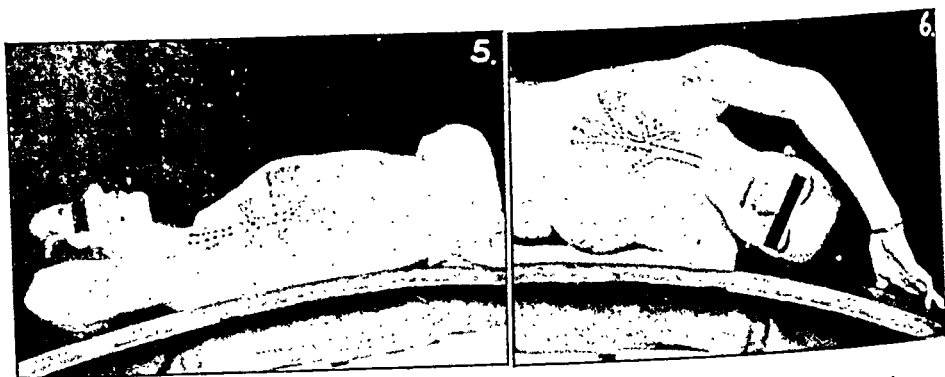


(3) Apical (right upper lobe).



(4) Combined apical and posterolateral (left upper lobe).

FIG. 6.



(5) Anterior middle (right middle lobe).

(6) Lateral middle (right middle lobe).



(7) Anterior basic (right lower lobe).

(8) Middle basic (right lower lobe).

FIG. 7.



(9) Dorsal (right lower lobe).

(10) Posterior basic and cardiac (right lower lobe).

FIG. 8

The remaining segments of the left lung are drained in positions similar to those shown for the right lung.

## Section of Anæsthetics

President—A. W. MATTHEW

[March 5, 1943]

### The Time Factor in Surgical Operations

By JOHN GILLIES, M.C., M.B., D.A.

DURATION-TIME of surgical operations is frequently a factor which ought not to be disregarded. Just as the aged person, forced to bed by an immobilizing accident, may develop hypostatic congestion of the lungs and anoxia in a few days' time, so the individual lying on an operating table with his respiratory and circulatory functions and metabolism depressed by an inhalational anæsthetic or by spinal block analgesia may develop pneumonia, but in a much shorter time. Whether he does so or not depends upon a number of factors, including the type and duration of the operation, the anæsthetic agent and its mode of administration, the depth of anæsthesia, and the extent to which physiological processes are deranged.

With advances in surgery the time factor is to a certain extent ignored, partly because of the faith which anæsthetists have engendered and fostered in the less toxic agents and newer methods now employed. Under the present abnormal conditions, also, there is growing up a group of younger surgeons in wholetime hospital service who, untrammelled by the rush of competitive surgery, develop what might be called an easy-going tempo. The same might be said of some of the younger generation of anæsthetists who tend to over-elaborate their part and so extend unnecessarily the time during which the patient is under the anæsthetic.

In the first place then, reference must be made to avoidable delays, particularly the tiresome minutiae which sometimes prolong the interval between the commencement of the anæsthetic and the making of the first incision. For example, in the matter of endotracheal technique, the anæsthetist must ensure that the patient is fully anæsthetized before trying to intubate the trachea. While it is frequently easy to intubate rapidly the patient whose cough reflex still remains active, it is not, for various reasons, the best practice. One feels that the inexperienced anæsthetist is often tempted to save time but only wastes it by premature attempts at passing a tube. Again, in attempting blind intubation under pentothal sodium, time is frequently wasted because of the tendency for laryngeal spasm to occur after an abortive first effort. It ought to be unnecessary, but unfortunately it is not so, to warn the enthusiast against wholesale intubation. To spend time passing endotracheal tubes in cases where such a method is not essential, is unjustifiable and helps to bring into disrepute one of the most valuable methods of anæsthetic administration available to-day.

Again, in the second stage of induction, there is often a hesitancy in the management of the anæsthetic. The struggling and breath-holding accompanied by anoxæmia which sometimes occur during a lengthy second stage, may produce deleterious effects such as raised intracranial tension and its sequelæ, especially in hypertensive patients. On this account, recovery from the anæsthetic, let alone the operation, may be considerably prejudiced. Prolonged anoxæmia must be avoided in all cases, chiefly because of the cerebral trauma that may ensue (Courville, 1936; Schreiber, 1939; Löwenberg and Zbinden, 1938). The relative oxygen lack which may occur in patients with a high oxygen demand, for example in hyperthyroidism and other states where the metabolic rate is raised, is less easily discerned but is all the more serious if allowed to continue for any length of time.



Prolonged deep anaesthesia involving saturation of the tissues, with ether for instance, affects adversely the utilization of oxygen by the tissue cells and initiates tissue asphyxia. Gill's "law of diminishing resistance" (Gill, 1906), which stated that "the amount of a drug required to produce a given depth of anaesthesia diminishes with the time of its administration", might in the light of present-day physiology be more precisely described as "the law of increasing anoxia".

Little is contained in the literature concerning the time factor, although most authors take cognizance of it. Langton Hewer (1943) says: "Modern anaesthesia has made possible operations of a severity and duration unthought of thirty years ago. There is a regrettable tendency, however, to prolong operations and thus increase shock. Overdose of anaesthetic, relative or absolute, oxygen deficiency and excessive duration of operation become cumulative after a certain length of time." Hewer quotes G. Kaye who states: "It is now generally held that a patient must not be left for more than twenty minutes with a systolic pressure below 80 mm.Hg or a diastolic pressure of less than 60 mm.Hg. If this is appreciably exceeded, death is extremely probable within forty-eight hours" (Kaye, 1937).

Nosworthy (1935) considers that the duration of operation is important in so far as the longer a shock-producing factor is in action, the greater will be the degree of shock produced. He continues: "Whether it is better in the absence of regional anaesthesia to cram a number of shock impulses into a short space of time and finish the operation quickly or to spread the same number of similar impulses over a longer period is questionable." Whilst in intrathoracic and intracranial surgery it may be necessary to allow intervals in order that retraction pressure on vital structures should be intermitted, for most operations under general anaesthesia there can be little doubt that, provided the viscera are handled with reasonable gentleness, there is no call to prolong the time unduly in order to reduce the shock-producing effect of sensory stimulation. The longer the operating time, the greater will be the heat and fluid loss and toxicity from the anaesthetic agent.

Magill (1938), discussing post-operative morbidity, states: "It has been shown that the nature and duration of the operation have as great a bearing on the incidence of post-operative pulmonary complications as the anaesthetic used. The depth of anaesthesia required in the case of an upper abdominal operation subjects the pulmonary bases to a period of inactivity from which only the robust patient can escape unharmed." To this one might add that the sluggish venous drainage which follows reduced pulmonary activity aggravates the state of sub-oxygenation already present, and so hastens the development of anoxia which, as Chase (1941) has pointed out, is the biggest single hazard to which the surgical patient is exposed. The longer the period of respiratory depression, the greater will be that hazard.

The opinion of the majority of surgeons and anaesthetists would probably hold that the problem is not simply one of the time taken to perform the operation, but the period during which the patient is subjected to the influence of depressant drugs. The pre-medication, the anaesthetic proper and the post-anaesthetic medication given in the first seventy-two hours, are all concerned together. To follow heavy premedication with prolonged deep general anaesthesia or to allow an anoxic state to supervene during spinal or regional analgesia, can only result in such a degree of post-operative, respiratory and circulatory depression that the patient's life is placed in jeopardy. Dawkins (1936) and others have emphasized the detrimental effects of excessive premedication and basal narcosis.

The factor of post-medication is important in so far as it effects a prolongation of the deranged physiology produced during operation. The nature of the operation may be significant, not only for the abnormal conditions which it creates at the time, but also for the more immediate after-effects on the patient, and the extent to which sedative and analgesic drugs may be required. In this connexion an investigation was made into the morbidity and mortality in a series of operations for perforated peptic ulcer—all performed in the same surgical unit.<sup>1</sup> Of 275 cases, 231 were treated by simple suture and 44 had gastro-jejunostomy done in addition. Post-operative respiratory complications developed in 37 (16%) of the former group with 16 deaths (6.9%), whilst in the latter group the figures were 3 (7%) and 1 (2.3%) respectively. Deaths from other causes such as circulatory failure, peritonitis, &c., were practically in equal ratio in the two groups, being 12.6% and 13.6%. Post-operative progress of the gastro-jejunostomy cases was usually smoother, possibly due to an absence of spasm in the oedematous perforation area. In such circumstances, less post-operative analgesic sedation is

<sup>1</sup> The permission of Sir John Fraser to examine the case records is gratefully acknowledged.

necessary, an important factor in preventing the undesirable prolongation of respiratory and circulatory depression. Judin (1937) reported a series of 418 operations for perforated peptic ulcer. Of 381 treated by resection (Billroth, I., or Polya-Balfour) 26 died (7·8%). Suture of ulcer and gastro-jejunostomy were performed in 35 cases with 5 deaths (14·3%), and in 52 cases of simple suture 23 died (44·2%). It is probable that a more comfortable post-operative period follows after removal of the ulcer-bearing area than after more conservative measures. It must also be remembered that probably the fitter patients had the gastro-enterostomy as well.

The series of 231 cases upon which simple suture was performed was reviewed (tables not reproduced) from the standpoint of anæsthetic technique. The majority of these, numbering 186, were given an inhalational anæsthetic, ether being the main agent. In the earliest cases of the series perhalational ether by the Ogston mask was employed. Then followed a period when the routine anæsthetic was endotracheal gas, oxygen and ether, administered from Boyle's apparatus with dry flowmeters. The patients in the latest chronological group had ether and oxygen by the closed circuit CO<sub>2</sub> absorption technique. Respiratory morbidity after operation showed a similar incidence when the simple mask method and closed circuit apparatus were used, the figures being 13·8% and 12·1%. The disappointing figure for the closed circuit method is possibly accounted for by the fact that the majority of the anæsthetics were administered by students, and the tendency with inexperienced personnel using such apparatus is to maintain anaesthesia at too deep a plane. In any case, simple closure of a perforated peptic ulcer is rarely a long procedure, and the usual time of ten to thirty minutes does not allow for the disadvantages of the open method to become apparent any more than it makes manifest the virtues of the closed circuit technique. It is in longer operations of one hour and upwards that the advantages of the latter become obvious.

The outstanding feature, however, was the high respiratory morbidity (27%) and respiratory mortality (8%) which occurred in the patients anæsthetized with gas, oxygen and ether delivered through an endotracheal tube and from a semi-closed apparatus (Boyle). This method has two adverse physical features, (1) the by-passing of the nose which is the natural air-conditioning apparatus of the body, and (2) the low temperature of the anæsthetic vapour. In regard to (1), the nostrils warm and add water vapour to the inhaled air. As much as one litre of water may be secreted and vaporized thus in twenty-four hours (Thomson and Negus, 1937). The mechanism is a self-regulating one which adjusts itself according to the temperature and humidity of the entering air. If the nose is by-passed as in bronchoscopy, there is a loss of heat and water vapour with each exhalation and no compensation during inhalation. This causes drying and irritation of the bronchial mucosa with some appreciable constriction in calibre of the bronchi and bronchioles, a condition which can be reversed by the insufflation of warm, moist air (Martin, 1942). Some degree of water vapour loss with inadequate replacement must take place when a patient continues to breathe for any considerable time through an endotracheal tube connected to a semi-closed apparatus and this must be an important contributory factor in the higher incidence of respiratory morbidity when such a method is used. In investigating (2), the temperature of the anæsthetic vapour, each case was intubated and a heat insulated thermocouple lead passed down inside the tracheal tube until its terminal lay just in the bevelled distal opening. The temperature recorded at the bifurcation of the trachea was that of the air or anæsthetic vapour at that point, and not a contact temperature of the tracheal mucosa. Other terminals were placed in the rectum, the soda lime and the ether vaporizer. Space does not permit of reproduction of the temperature charts, but briefly the observations were as follows.

Under intravenous pentothal sodium anæsthesia the temperature of the tidal air at the tracheal bifurcation was 34° to 35° C. (theatre temperature 23° C.). When nitrous oxide and oxygen (total flow, 9 litres per minute) was administered through the tube, the temperature fell 1° to 2° C., but after several minutes returned to almost the original level as a result of rebreathing. The most considerable change occurred when the gases were passed through either in a Boyle apparatus. Falls of temperature of 5° to 7° C. were recorded. This must be of definite significance in prolonged operations, especially when other shock-contributory factors are present, as, for example, blood loss and heat loss by radiation from exposed viscera. The endotracheal administration of gas, oxygen and ether by semi-closed apparatus (Boyle) was found to be more detrimental in regard to heat loss than ether by an open mask. In the latter method the patient does at least have the benefit of some warming by the nose of the vapour he is inhaling, which of course is true also for Boyle's apparatus when a facepiece is used instead of a tracheal tube.

In cases where a closed circuit apparatus ( $\text{CO}_2$  absorption) was substituted for a semi-closed one during the course of operation, a rise of  $2^\circ$  to  $3^\circ$  C. in the temperature of the ether oxygen mixture at the tracheal bifurcation was recorded. Even so, this temperature was usually lower than that of the rectum so that heat transference from the body to the circulating vapour was still going on. When, however, the "to and fro"  $\text{CO}_2$  absorption technique was employed, with the soda lime canister and rebreathing bag connected close to the tracheal tube, there was less dissipation of heat by the apparatus, and this, together with the higher temperature maintained in the soda lime, produced a temperature in the trachea at least equal to that in the rectum.

Using cyclopropane the tracheal temperature readings remained constantly higher than those taken in the rectum. This must be a positive aid in counteracting heat loss, particularly during long operations. Even with an open chest, as in one case of pneumonectomy, this higher temperature was maintained. For efficient maintenance of temperature and conservation of heat and water vapour, the Waters to-and-fro absorption method gave the best results. Although the temperature of the soda lime rises high ( $50^\circ$  C. was recorded), the temperature of the gases inhaled is quickly modified and is not excessive (i.e. not above  $37^\circ$  C.) at the bifurcation of the trachea. The low specific heat of gases, the continuous inflow of 300 to 500 c.c. per minute of fresh oxygen and quiet respiration are the chief modifying factors. It should be noted that the environmental (theatre) temperature was relatively low,  $23^\circ$  to  $24^\circ$  C., compared with what pertains in some other climates. Knight (1942) working in theatre temperatures varying from  $30^\circ$  to  $37^\circ$  C., considers that the extra heat from  $\text{CO}_2$  absorption apparatus causes overheating of the patient, and under such conditions has found it necessary to devise means for cooling the gases.

For a lengthy operation, the technique of closed anaesthesia with  $\text{CO}_2$  absorption, not only fulfils the requirements of the surgeon, but also helps greatly to mitigate the derangement of respiratory and circulatory function which frequently occurs during long operations and persists in the post-operative period. But even the skilful use of the closed method will not save the patient from the toxic effects of a potent anaesthetic agent distributed throughout the tissues for a long time. If prolonged muscular relaxation is demanded, it should be achieved by nerve block (spinal or regional) whilst the patient is kept just below the level of consciousness by the administration of nitrous oxide or cyclopropane along with a sufficiently high concentration of oxygen to combat anoxia. Intravenous pentothal sodium is an alternative to gas or cyclopropane, but its dosage throughout a long operation should be minimal and uniformly controlled and adequate oxygenation maintained. The anaesthetist's work does not end at the close of the operation. He must take measures to hasten the elimination of the anaesthetic drug and take an interest and share in the directing of post-medication. Thus will he help still further to modify the time factor by preventing unnecessary prolongation of the effects of the drugs he has administered.

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Dr. Geoffrey Organe showed a number of anaesthetic records demonstrating instances of prolonged anaesthesia—four to six hours—in patients of ages varying from 8 to 43.

He then continued: These charts, selected as nearly perfect, show that prolonged unconsciousness from anaesthetics, alone, need have no ill-effect whatsoever. For the much commoner case where some degree of operative shock develops, we must look for other factors than time. These examples include a variety of techniques but all except the last were intubated; I cannot agree with Dr. Gillies that intubation has any ill-effect.

Surgical trauma under very light anaesthesia does not, in my experience, cause shock except in one or two special cases such as splanchnic stimulation from rough handling of viscera, and disarticulation of the hip or shoulder-joint.

Clumsy induction of anaesthesia with struggling and spasm, and prolonged respiratory obstruction, exhaust the patient and are important contributory factors.

Of prolonged deep anæsthesia, I have no material on which I could base an opinion. Certainly deep morphine narcosis has no detectable ill-effect. It is difficult, too, to attribute operative shock to the use of any particular anæsthetic agent.

Prolonged low blood pressure is said to lead to shock. I have the chart of a woman with an 8th nerve tumour, in whom I produced a fall of blood-pressure from 120/85 to 85/50 mm.Hg by a clumsy induction. The level remained steady until the end of the operation four hours later, and she made a good recovery.

Hæmorrhage, whether sudden or sustained, will lead to shock, but this could probably be avoided if our supportive measures were more efficient. Exposure, especially of the chest wall after radical mastectomy, will produce a rapid fall of blood-pressure, whether due to loss of heat and moisture or to stimulation of cut nerves by drying.

Even where shock already exists, the time factor is not necessarily important. A girl of 19 with a pulse-rate of 120 and blood-pressure 80/50 mm.Hg was anæsthetized for nearly four hours with endotracheal nitrous oxide, oxygen and ether for suture of multiple face wounds. Her condition did not deteriorate in any detectable way.

I do not like prolonged oxygen lack and I was surprised to find a chart of a boy of 5 with a cerebral tumour to whom I gave only 11% of oxygen for more than four hours. His blood-pressure and pulse were unaltered and he woke on the table.

Sudden change of posture is a most important contributory factor. A woman of 43 had a lumbar sympathectomy under spinal anæsthesia and cyclopropane. The blood-pressure was unaltered for two hours, when too rapid a change from head-down to horizontal produced a severe fall. Readings taken immediately after an operation may show a fall as big as 50 mm.Hg due to rough handling while cleaning up and applying bandages.

We may avoid these changes even in prolonged severe operations if we use an intravenous barbiturate to ensure smooth induction, and if we use spinal or local with light general anæsthesia. Intravenous saline should be given from the start of a major operation, and blood added at the first sign of a drop in blood-pressure. The importance of warmth is obvious.

Few thyroidectomies will survive an operation of more than three hours; it may be that our methods of anæsthesia are inadequate.

The only result of the time factor that we cannot avoid is the increased tendency to post-operative chest complications.

**Mr. Harvey Jackson:** Operations on the head require but a minimum of anæsthetic, any depth of anæsthesia being necessary purely for dealing with the scalp, the other structures being more or less insensitive (apart from certain blood-vessels).

What we have to ask ourselves primarily is, how essential is prolongation of operative procedure? Herein lies a problem the answer to which is best studied by reference to the work of that great neurological surgeon, Dr. Harvey Cushing, who showed that speed was by no means essential in intracranial operations, in fact prolongation of the intervention was found to be necessary to the control of cerebral trauma arising out of rapid, if perhaps forceful, manipulation. Cushing, however, was a pupil of Halstead, a surgeon well known for his slowness in operating, and he was imbued by the slowness to the extent of deliberate prolongation as a supposed quality of technique. Pupils of Cushing have seen in this what they interpret in terms of indispensability. No doubt some benefit accrues from the avoidance of forceful manipulation, but the matter has now reached absurdity in that operations may be drawn out over twelve or more hours. This tendency is partly the outcome of present-day specialization before an adequate surgical training has been acquired—a lack of surgical dexterity is veiled in deliberate protraction of the period of intervention. It was my privilege to have worked under the late Sir Percy Sargent, as well as with ardent followers of the so-called Cushing Technique; never shall I forget the manipulative skill of Sargent nor the quality of his results.

Dr. Gillies referred in particular to pituitary tumours to offer in defence of a drawn-out technique the likelihood of hypothalamic disturbance from rapid approach. In Sir Percy Sargent's hands this operation took little more than one hour, and I am able to say from personal experience of his cases that his results compared favourably with similar cases in other hands. My own time for carrying out a transfrontal operation for pituitary neoplasm is in the neighbourhood of one and three-quarter hours. Dexterous manipulation offers a speedy approach without the risk put forward by Dr. Gillies; indeed, in my opinion, much wider damage to cerebral structure is liable to occur from tardy procedure as prolonged retraction must hold coincident devascularization of the retracted tissues.

On occasions when presented with very ill children both Dr. Mennell and I have felt that only by curtailment of the duration of the operation could any reasonable prospect of post-operative recovery be contemplated. Thereupon we have decided, as far as reasonably practicable, to restrict the operation to an hour, and I may add that the anæsthetic employed has been chloroform. This at the present day would appear almost heretical, but the value of such a drug is now nearly forgotten. The use of chloroform in these circumstances has proved most satisfactory, but that statement must not be taken to imply that it should be administered by those unaccustomed to its use.

Dr. Gillies has shown some most interesting figures, but how misrepresentative statistics can be. Reading into his figures of the various forms of intervention applied to the treatment of a perforated ulcer it can be seen how ludicrous an interpretation could be drawn; in suggesting that to attain improvement in morbidity or mortality rates, relying on his figures, one has only to supplement closure of the perforation by such measures as appendicectomy, gastro-enterostomy, or even partial gastrectomy.

**Major R. A. Gordon, R.C.A.M.C.:** Dr. Organe has presented one case of a patient undergoing intracranial operation, who suffered a long period of hypotension with systolic pres-

sure of round 80 mm.Hg for a matter of hours, with uneventful recovery, and ventures the opinion that such a period of hypotension has no adverse effect on such a patient. All those who have had experience with this type of patient will agree with me that such a prolonged period of hypotension definitely prejudices the patient's post-operative recovery. He has also shown records of a case in which an operation, lasting some three hours, was undertaken on a patient who suffered from hypotension with systolic pressure of around 80 mm.Hg. He pointed out that this patient was apparently undisturbed by such a period of profound hypotension, and stated that it was his opinion that in such patients under light anaesthesia such hypotension was not of great consequence. I feel very strongly that it is an error of judgment to expose any patient suffering from such a degree of hypotension to anaesthetic or operative procedures, unless these be immediately necessary for preservation of life, without first treating the circulatory collapse.

The duration of anaesthesia is certainly of importance in the case of patients who have, or will have post-operatively, pus or blood, or other foreign matter in the mouth and pharynx. No matter how lightly a patient may be anaesthetized during operation the post-anaesthetic period of depression is directly related to the duration of anaesthesia, and it is necessary that patients of this type should be fully recovered at the earliest possible moment.

Dr. Z. Mennell said that from the anaesthetist's viewpoint, always presupposing the same gentleness and skill on the part of the surgeon, the quicker an operation is done, the less shock for the patient. In his Embley lecture in Melbourne he had hinted that he could not understand and did not like the modern deliberate surgery. For this he had been seriously attacked by the *Australian Medical Journal*, but with the help of the late Sir Squire Sprigg they had been obliged to publish a reply which contained figures which could not otherwise have been properly quoted by an anaesthetist. Enough had been said about cerebral surgery and his views were well known by the Section.

To turn to other branches of surgery, he cited prostatectomy where speed was certainly an important factor, for reasons that must be obvious. He was firmly convinced from long experience that speed was one of the greatest factors of safety in surgery, and there was a tendency for some surgeons to abuse the skill of the anaesthetist, and to carry out an excessive technique at the expense of surgery and to the ultimate detriment of the patient.

[May 7, 1943]

## Trichlorethylene Anaesthesia by the Single-Dose Method

By A. H. GALLEY, M.B., B.S., D.A.

**Introduction.**—The use of trichlorethylene by the new method was quite fortuitous and was due to the fact that at one time vinyl-ether had been in short supply thereby compelling the speaker to search for an alternative agent. The method had been employed for anaesthetizing children both for dental extraction and guillotine tonsillectomy. The dental clinics of the Borough of Tottenham were chosen for the original research as it was there possible to arrange whole sessions of children only (or mainly of children), thus facilitating the comparison of the effect of varying dosage from case to case, also because the health visitors of the borough could follow up and report upon the condition of the patients the next day.

**Apparatus.**—Two similar pieces of apparatus had been used: the Goldman inhaler and its Oxford modification; the latter proving the better as it was possible to produce a gradual increase of vapour tension and consequently a smoother induction.

**Dosage.**—1.5 c.c. had proved adequate for dental extractions but for the guillotine tonsillectomies larger quantities had proved necessary, i.e. 3 c.c. for children up to 5 years of age and 5 c.c. for older children.

**Induction.**—Dental cases required no premedication and air could be given as required by manual occlusion of the neck of the rebreathing-bag at the commencement of an inspiration, when the emergency inspiratory valve would come into action. One or two breaths of air were enough during most inductions, the colour remaining remarkably good. (Each case must be treated upon its merits, however.) After from 60 to 90 seconds automatic respiration became established and another 20 to 40 seconds rebreathing were necessary to produce a useful length of anaesthesia; within limits the longer rebreathing was kept up the longer was the anaesthesia that ensued. In Dr. Galley's opinion an estimation of the length of anaesthesia likely to be produced was more difficult than when using vinyl ether; he therefore erred on the short side as owing to the well-known amnesic effects of trichlorethylene, even if the last tooth or two were extracted with a whimper no memory of the event remained. The addition of oxygen to the mixture had proved redundant and, indeed, it only retarded the induction. When anaesthetizing for tonsil-

lectomy, however, with darkened operating room, oxygen had been added to prevent any possibility of anoxæmia; carbon dioxide cautiously added had speeded up the induction.

### CONCLUSIONS

Single-dose trichlorethylene anæsthesia closely resembled single-dose vinyl-ether administration, owing, no doubt, to the similarity in the apparatus employed. Salivation was usually absent or at worst much less evident than when using vinyl ether. It shared with vinyl ether that lack of anoxæmia (with its consequent venous congestion) that was such a drawback when operating under nitrous oxide anæsthesia. Laryngeal spasm appeared non-existent, in dramatic contrast to ethyl chloride and those cases under vinyl ether where saliva inadvertently gravitated on to the vocal cords. All cases were followed up by the health visitors who reported no untoward sequelæ (sickness, vomiting, nausea or headache) the day following extraction. The tonsillectomy cases were all in hospital and with the exception of one child (who was operated upon against Dr. Galley's advice, developed bilateral multilobular atelectasis and recovered within twenty-four hours) the convalescence was markedly improved when compared with ethyl chloride or ethyl chloride-ether sequence anæsthesia. Trichlorethylene was very much cheaper than either of the other anæsthetics mentioned, a whole session of administrations costing only a few pence.

## Further Observations on Trichlorethylene

By C. LANGTON HEWER, M.B., B.S., D.A.

My previous paper on trichlorethylene read before the Section (1942) a year ago was based upon 400 administrations. Since that date, the drug has been used extensively at Hill End Hospital and my colleagues (Mr. B. Rait-Smith and Mr. H. R. Marrett) and I have given it upon over 3,700 occasions, so that more extensive data are now available.

*Indications.*—We have found that trichlorethylene is especially useful in the induction of anæsthesia when added to nitrous oxide and oxygen. The onset of anæsthesia is smoother and takes less time than with ether. In the average patient with light pre-medication, four minutes suffice from consciousness to the third stage. If intravenous pentothal is given the time will be slightly longer owing to respiratory depression. In the majority of patients undergoing major surgery, the induction of anæsthesia has been with this technique. Narcosis may be maintained with the same mixture if complete muscular relaxation is not required. As a rule there is no difficulty in intubating either nasally or orally should this be desirable. We have found endotracheal nitrous oxide-oxygen-trichlorethylene particularly useful in ophthalmic surgery where capillary oozing is definitely less than with ether and the dreaded post-operative vomiting is rare. Replacements of detached retinae can be done with this method as, in spite of statements to the contrary (Stowell, 1943), the diathermic cautery is no contra-indication to its use. It might, perhaps, be well to clear this point up. Trichlorethylene vapour will not burn or explode if mixed in any proportion with air, oxygen or nitrous oxide. If sparking occurs in a strong vapour of the drug, a minute amount of phosgene may be formed in the immediate neighbourhood of the spark but, even if pharyngeal insufflation without packing is being done, the quantity inhaled by the patient is infinitesimal. With endotracheal anæsthesia using a cuffed tube or a pack, none at all can be inhaled. This also applies, of course, to chloroform.

If sufficient relaxation cannot be obtained easily, it is far better to change over to some other drug such as ether than to push trichlorethylene to a very deep plane. When adequate relaxation is attained with ether, a second change back to trichlorethylene will usually enable this deep plane of narcosis to be held. I believe that most of the troubles encountered have been due to neglect of this advice. For example, an extremely rapid respiration rate is seldom seen with the technique described but, if it should occur, I should not hesitate to change over to some other drug although I have never seen any harm arise from this cause.

The "safety-factor", i.e. the ratio of the minimum lethal dose to the anæsthetic dose, would appear to be very much higher with trichlorethylene than with chloroform. I have only seen respiratory arrest occur on one occasion and then only for a very brief time.

I have not tried the intravenous injection of curare to produce complete relaxation in light trichlorethylene anæsthesia but the practice may have possibilities (Griffith and Johnson, 1942; Barnes, 1943).

*Cardiovascular changes.*—Further experience has confirmed our previous observations that blood-pressure changes are negligible, but that capillary oozing from cut surfaces is definitely less than with ether. As regards the pulse-rate, bradycardia is commoner than tachycardia as is the case with cyclopropane. Arrhythmias are fairly common and seem to have given rise to much anxiety in some observers (Gordon and Shackleton, 1943). We have never had any uneasiness on this account in any patient. Although we have not continued electro-cardiographic records, we did show before that most of the pulse irregularities were of the nature of auricular extrasystoles. It appears to me rather doubtful whether the type of E.C.G. changes is of much assistance in determining the suitability of an anæsthetic agent. For example, we should probably never have used cyclopropane at all if we had been influenced solely by the opinion of cardiologists after studying E.C.G. tracings with this gas.

The question of primary cardiac failure is, on the other hand, of great importance. So far as I know, one case only has been recorded which occurred in a girl aged 3 with a history of bronchitis who was undergoing a herniorrhaphy. Unfortunately no details are given but it was concluded that the cause of death was "vagal inhibition" (Haworth and Duff, 1943). It is probable that over 100,000 administrations of trichlorethylene have now been given and it is hardly conceivable that if primary cardiac failure was anything like as common as with chloroform, we should not have heard of many more such accidents. Two other deaths occurring during narcosis have come to my notice but from the particulars which I have been able to obtain, neither case comes into this category.

*Convulsions.*—Two mild cases of convulsions have been recorded. Both recovered spontaneously and the temperature in each case was normal in contradistinction to most reported cases of ether convulsions (Garland, 1942; Culbert, 1942). We have not seen this condition ourselves but an anæsthetist in conversation remarked that he had had twitchings in one case which ceased when the oxygen percentage in the mixture was increased. This suggests that anoxia may be a factor in the ætiology.

*Acetonuria.*—I should like to revise my previous remarks about the rarity of acetonuria after trichlorethylene anaesthesia. Subsequent experience has shown that the presence of acetone in the urine is commoner than I had previously supposed. This may be due to the fact that a large number of children have been anaesthetized with this drug. Severe ketosis, however, has never been encountered.

*Fifth nerve palsies.*—It may be recalled that the reason why trichlorethylene was first tried as a palliative for trigeminal neuralgia was that some of the fatal cases of industrial poisoning with the impure product showed bilateral lesions of the fifth nerves and it was thought that some specific action on these nerves existed. In my former paper I explained why I thought it much more likely that the relief from pain which undoubtedly occurs when trichlorethylene vapour is inhaled, is due to a state of general analgesia.

A few months ago, it was brought to my notice that three cases of fifth nerve palsy had followed trichlorethylene anaesthesia in one hospital within quite a short time. On investigation it appeared that the first case was the most marked and that the condition had not entirely cleared up although the patient had recovered from his operation and had been transferred to a convalescent home. The other two cases were much less severe and would probably have been missed unless the first had occurred. Both patients recovered before they left the hospital. On thinking over the facts, it seemed to me very curious that three cases had occurred almost simultaneously at one hospital while diligent inquiries failed to elicit any other cases elsewhere. I therefore came to the conclusion that there must be some local cause and the most likely one appeared to be impurities in the drug. Fortunately about 100 c.c. of the fluid from the suspected bottle had been kept and this was sealed and sent to the makers for analysis. Their report was that it contained at least 20% impurities in the form of mixed hydrocarbons, probably either naphtha or petrol. Since the vapours of either product when inhaled are known to be able to cause neuritis, part of the mystery was solved. The test bottle of the same batch of trilene retained by the makers was then examined and found to be quite pure so that there is no reasonable doubt that the contamination occurred after delivery. Various speculations as to how this occurred can be made. Personally I think it quite likely that some person connected with the dispensary or theatre discovered that trichlorethylene can be used to clean clothes as well as to anaesthetize patients and that he abstracted some for this purpose. In order that the fraud should not be discovered, he may then have filled up the bottle with petrol.

It is of some interest to know that the makers have had another bottle of trilene returned to them for analysis on account of toxic symptoms. On examination, this was found to contain no less than 40% chloroform. It is not so difficult to see how this contamination

arose but such mistakes should not occur now that trilene is coloured blue. At the same time, care must be exercised by the theatre staff when emptying and filling the bottles on gas-oxygen apparatus and all concerned should be able to distinguish trilene from chloroform not only by colour but by odour.

*New developments in technique.*—I do not propose to dwell upon the new techniques for giving trichlorethylene which have been worked out by various anæsthetists as I have not had sufficient experience to express an opinion. These include the production of general analgesia in dentistry and midwifery, the single-dose method already described this afternoon by Dr. Galley and the combination with avertin for producing complete relaxation in abdominal surgery.

### CONCLUSION

From the large number of administrations now made, I think we are justified in saying that, within its known limitations, trichlorethylene is a useful agent in the production of general analgesia and anæsthesia.

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## A New Instrument for Visual Determination of Blood-pressure

### PART I. PHYSICAL CONSIDERATIONS

By DAVID S. EVANS and K. MENDELSSOHN<sup>1</sup>

(Clarendon Laboratory, Oxford)

OUR object was not so much to devise a complex instrument suitable, for instance, for physiological research, but to design a simple machine giving the optimum practical assistance to anæsthetist and surgeon, which should be robust enough to stand up to war-time usage, and sufficiently free from complex refinements to work for long periods without servicing. It had to give unambiguous readings of systolic and diastolic pressures, preferably by means of a visual indication, and it had also, if possible, to give some continuous indication of the patient's condition.

The result embodies no new principle, but is the product of a scientific analysis of the conditions of blood-pressure measurement so as to secure the best possible combination of existing methods and apparatus. This analysis is based on certain simplifying assumptions, such as, for instance, that the artery is a simple linearly extensible tube, but, as we shall see, the simplicity of the assumptions does not invalidate the theory, which predicts results which are in excellent agreement with observation.

We use an inflated cuff of the usual type, connected to a differential membrane manometer, which records pressure oscillations by means of a light beam and scale. Pressure pulsations from the cuff are led directly into one side of the manometer, but the other chamber is connected to the cuff through a capillary. This equalizes the mean pressures on the two sides of the membrane, but admits rapid pressure changes such as pulsations, to one side only. The mean pressure in the whole circuit is recorded on an aneroid manometer.

The theory predicts that the amplitude of pressure oscillations recorded by the membrane manometer will be related to the mean pressure in the cuff by a curve of the type shown in fig. 1. For cuff pressures above systolic the pulsations are small. As the cuff pressure falls they increase to a maximum and then slowly decrease again. Then suddenly there is a sharp break in the curve, after which the pulsations are small and decrease

<sup>1</sup> With a personal grant from the Medical Research Council.



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say, 25 mm. of mercury, then the size of the recorded pulsations is a measure of the patient's pulse pressure. The machine can be left set in this way for long periods, and gives at a glance an indication of the patient's pulse pressure and heart rate.

To summarize: The detecting cuff only is used for measuring diastolic pressure, the sharp break in the size of pulsation being used as the criterion. For the measurement of systolic pressure both cuffs are needed, and the sudden onset of pulsations in the detector is used as the criterion. The detecting cuff alone, inflated to a constant pressure gives an indication of pulse pressure and heart rate.

The practical details of construction have needed some care. The membrane manometer cannot be inflated through the capillary without damage. A wide by-pass giving a free connexion between the two chambers of the manometer is therefore opened for inflation, and for safety this by-pass is linked to a tap on the inflation line, so that inflation is impossible when the by-pass is closed for recording. The taps themselves are leak-proof, so that a pressure once set is maintained indefinitely. Their working parts are completely enclosed, and there are no barrels which need lubrication or packing.

## PART II. CLINICAL ASPECTS

By F. BARNETT MALLINSON

THERE are several advantages to be derived from keeping records of blood-pressure during surgical operations. A chart of the patient's condition stretching back into the immediate past during the course of a severe operation is obtained, which is of great value in assessing his condition and estimating his capacity to withstand the infliction of further trauma, thus facilitating the adaptation of the surgeon's operational measures to the patient's best advantage. This charted record also enables the anæsthetist to anticipate the onset of surgical shock and take measures to control it in good time.

Experience during the London air-raids has proved to us beyond question that the value of prevention and control of severe shock before and during operation vastly outweighs all efforts at post-operative resuscitation. Lastly, study and interpretation of completed records in the light of the patient's post-operative progress teaches a great deal about the science of anæsthesia in general.

Blood-pressure control, particularly observation of the pulse pressure, during resuscitation of the severely shocked patient is essential if consistent and successful results are to be achieved in the determination of the optimum time for operation.

Methods of blood-pressure estimation in common use are: (1) By palpation. (2) By auscultation. (3) Less frequently by visual observation.

The palpatory method can be dismissed as grossly inaccurate and leaves the more important figure of diastolic pressure unknown, therefore pulse pressure, the most important factor of the three, cannot be obtained.

The *auscultatory method* is that most commonly used, and with it systolic pressure is fairly accurately obtained, but it is generally agreed that the diastolic measurement is unsatisfactory; the results are often difficult to interpret and, moreover, their estimation, like the estimation of end-points by colour change, is liable to considerable individual variation. Occasionally (owing to the sounds being audible down to zero) an estimation is not possible. During operation or in a busy resuscitation ward various loud noises tend to make auditory phenomena difficult to detect. All of us must be familiar with the anæsthetist's nightmare—the strapped-on stethoscope, lying entirely inaccessible for adjustment under impenetrable drapes. Lastly, in cases when both arms are denied to the anæsthetist the legs are useless for auditory measurements of pressure.

*Visual estimation*, it has long been felt, would supply the solution to all these problems if only a satisfactory method could be evolved. Since Pachon designed his oscillogram, numerous attempts have been made to achieve a satisfactory instrument. The Recklinghausen apparatus has probably been the least unsatisfactory up till the present but, like the auditory method, it suffers from a lack of definition in estimating diastolic pressure. The so-called "edge effects" to which the method is liable tend to spoil to a certain extent the clarity of the systolic reading as well.

Just over a year ago (after several years of experimenting with many types and modifications of visual apparatus) my attention was drawn to the work of Drs. Mendelssohn

linearly to zero. The explanation is simple enough. At cuff pressure below diastolic the artery pulsates gently and produces small oscillations of the light beam. For pressures above diastolic the artery is collapsed during part of each heart cycle, the volume change is large, and there are large oscillations of the beam. As the cuff pressure falls, there is thus an abrupt changeover from large to small oscillations, which occurs exactly at diastolic pressure, and this effect is used as the criterion for measurement.

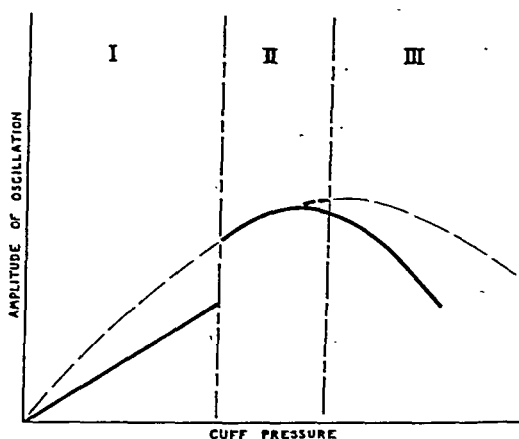


FIG. 1.

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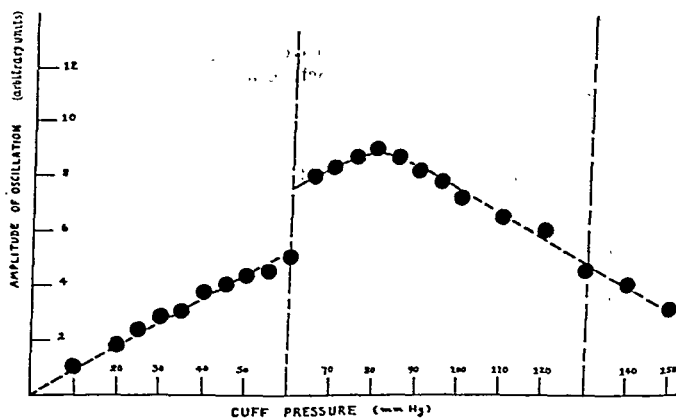


FIG. 2.

This theoretical analysis is amply confirmed by observation and fig. 2 shows one of a long series of observations, all of which give a curve of the correct shape with a sharp break.

The curve possesses no sharp feature which can be used to fix the position of systolic pressure, and we have therefore used a second cuff inflated independently, for this determination. The second cuff is placed proximal to the first and is used for occluding the artery. The first cuff, inflated to a moderate pressure, then serves as a detector. If the pressure in the proximal cuff is above systolic there is no blood flow and no pulsations in the detector. If the pressure in the proximal cuff is lowered, blood will begin to flow when its pressure is just equal to systolic, and pulsations will then start suddenly in the detecting cuff. This effect is used to determine systolic pressure.

A third use of the apparatus is for the continuous indication of pulse pressure. It can be shown that if the detecting cuff only is used, at a constant low pressure below diastolic,

(M) F -10 SEX (A) -20 -40 AGE (B) -60 61 & OVER		BRAIN & SPINAL CORD MOUTH, NOSE & THROAT THYROID OTHER HEAD & NECK INTRATHORACIC BODY-WALL UPPER LAPAROTOMY LOWER LAPAROTOMY INGUINAL G.U. PERINEAL EXTREMITIES MAJOR OPERATION MINOR OPERATION		TIME IN HRS. (L) 12 -2 2+ OPIATE PRE-MEDICATION (N) ORAL RECTAL	
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TECHNICAL (F) 1. EMERGENCY 2. I.V. THERAPY 3. C.V.S. DISTURBANCES 4. RESPIRATORY DISTURBANCES 5. ADMINISTRATION SATISFACTORY REFLEXES IN TH. WITHOUT COMPE. (H) MAX. DEPTH OF MAINTENANCE (J) 1 2 3 4		DURING ANAESTHESIA (G) 1. EMERGENCY 2. I.V. THERAPY 3. C.V.S. DISTURBANCES 4. RESPIRATORY DISTURBANCES 5. ADMINISTRATION SATISFACTORY REFLEXES IN TH. WITHOUT COMPE. (H) MAX. DEPTH OF MAINTENANCE (J) 1 2 3 4		REGIONAL SPINAL I.V. N <sub>2</sub> O C <sub>3</sub> H <sub>6</sub> ETHER ETHYL-CHLORIDE CHCL <sub>3</sub> OTHER AGENTS USED ONE TWO THREE TECHNICAL RESP. MAJOR RESP. MINOR .. 1-4 DAYS .. LATER C.V.S. FIRST 24 HRS. C.V.S. LATER C.N.S. G.U. OTHER NONE OF ABOVE VOMIT 0	
RESULT <input checked="" type="checkbox"/> UNINTERRUPTED CONVALESCENCE.		THE COVELAND-CHATTERSON PARAMOUNT CARD PAT. NO. 225069, 207692. C.C. 87797K		CAUSE OF DEATH (U) EXISTING DISEASE INFECTION RESPIRATORY C.V.S. ANAESTHESIA AUTOPSY PERFORMED LATER 4-14 DAYS 1-3 DAYS ON TABLE DIED TIME OF DEATH (S) (R) (Q) (P) ..-12 HRS. ..-24 HRS. ..24+ HRS.	

FIG. 1.

and Evans. Since then I have used and experimented clinically with all the alterations and modifications of their original apparatus which have resulted in this final experimental model now presented. This model I have had in constant use and have recorded more than 100 resuscitation and operation charts, besides providing several sets of figures in cases of arteriovenous aneurysm of the limbs and other circulatory abnormalities in which the auditory method could not satisfactorily be applied. The experience thus gained has been sufficient to convince me that here at last is a definitely improved system. Systolic pressure is estimated easily. Diastolic pressure is much more sharply defined than hitherto. Both estimations show a satisfying degree of consistency,  $\pm 2.3$  mm. mercury being a pretty constant limit of variation.

A feature quite new to me in clinical blood-pressure recording is the facility afforded by the instrument for continuous observation of pulse pressure. This is of great value during touch-and-go periods in operations on severely shocked patients, enabling the anaesthetist to watch minute-to-minute changes and to gauge response to transfusion and other measures at a glance, and from a distance of several feet if necessary, without his having to take repeated readings at a time when he is likely to be fully occupied.

[The apparatus was then demonstrated on one of the authors.]

## A Method of Keeping Anaesthetic Records and Assessing Results

By MICHAEL NOSWORTHY, M.D., D.A.

THE present aim was to combine on the same card the usual anaesthetic chart for collecting and recording all the relevant data as well as a method for assessing results statistically without having to use either a code book or a sorting machine. The anaesthetic record is printed on a card 8 in. by 5 in. in size.

*The principle of the method.*—Around the four sides of the card holes are punched. What each group of holes and each individual hole represents is shown by headings and subdivisions printed against them on the front of the card (fig. 1). Whilst the operation is in progress attention is given to the back of the card (fig. 2). Details of the operation performed and the anaesthetic administration are filled in, positive factors are encircled, and observations are recorded on the graphic chart.

The data collected at operation, like other positive factors noted on visiting the patient during his stay in hospital, are subsequently marked with a circle in their appropriate subdivisions round the sides on the front of the card. When the patient has left hospital the holes opposite the encircled positive factors are converted into slots by cutting out a "V" from the edge of the card opposite each with a pair of special nippers or scissors.

During sorting, later on, the slots permit the separation of the positive factors from the negative factors the holes opposite which will still be intact.

The preliminary ringing of all positive factors serves as a safeguard against the chance of a mistake in slotting. Finally, as proof that the record has been completed and is now ready for filing, the corner marked with the diagonal line is snipped off.

Sorting of a pack of completed records is accomplished by running a knitting needle through the hole representing the factor under consideration, by spreading the pack over its length in order to prevent any cards from clinging together, and then by raising the needle. For example, if it is desired to find mortality figures the needle is passed through the hole marked "DIED", and the cards of all patients who died in hospital—since they will have had this hole slotted—will fall from the pack; whereas the rest of the cards, representing all patients discharged from hospital, will be supported on the needle—since they will have the "DIED" hole left intact. By repeating this manœuvre it is possible to find quickly all statistical data required—e.g. the number of a given type of operation performed under a particular anaesthetic technique and the post-operative morbidity and mortality, &c.

A full descriptive article which explains in detail how the record card should be used will be found in the *British Journal of Anaesthesia*, 1943, vol. 18. The cards are made by the Copeland Chatterson Company, and can be obtained from Messrs. A. Charles King, Ltd., 27, Devonshire Street, London, W.1.

## Section of Comparative Medicine

President—A. FLEMING, F.R.C.S., F.R.S.

[February 17, 1943]

### DISCUSSION ON IMMUNITY. III.—IMMUNITY TO TUBERCULOSIS

Dr. G. Gregory Kayne (*Abstract*): In considering the subject of "immunity to tuberculosis" in man the term "resistance" is preferable to that of "immunity", and the subject may be divided into natural and acquired resistance. Natural resistance is the inherent ability of the body to restrain the growth and bring about the death of the tubercle bacillus on first contact with it. Acquired resistance follows primary infection; thus while natural resistance might influence the course of the primary infection, any development of later lesions would be determined by acquired resistance; and acquired resistance would act by killing bacilli freshly introduced into the body at the site of entrance (generally the lung), or at least by limiting the effects of the bacilli to the neighbourhood of this site. Acquired resistance was believed to act through the hypersensitivity of the tissues which develops at the same time. There are obvious difficulties in accepting this explanation in full.

A different concept of the relations between natural and acquired resistance can be evolved as a result of the findings among South African natives on the Rand (1932), *Publ. S. Afr. Inst. med. Res.*, 5, No. 30), the findings among negroes living in U.S.A. (Opie, E. L. (1924) *Amer. Rev. Tuberc.*, 10, 265, and Pinner, M., and Kasper, J. A. (1932), *Amer. Rev. Tuberc.*, 26, 463), and from the experimental observations of Lurie (Lurie, M. B. (1941), *Amer. Rev. Tuberc.*, 44, Suppl. to Sept. issue) among rabbits. All these findings show that racial and individual differences in natural resistance to tuberculosis exist both among animals and human beings. They also show that acquired resistance might be a function of natural resistance; in other words, people with a high natural resistance acquire further resistance as a result of the primary infection. The sum-total of natural and acquired resistance modifies the type of subsequent lesions in the manner described above, and these lesions are commonly observed in civilized communities. People with low natural resistance, on the other hand, such as the South African natives or U.S.A. negroes, often do not develop acquired resistance following primary infection, so that having overcome the primary infection under good environmental conditions, they react to a subsequent reinfection under bad environmental circumstances as if it also were a primary infection; that is, they again develop a primary complex with generalization. Again, according to Lurie's experiments in rabbits, strains with high natural resistance, following a first infection with tubercle bacilli, develop lesions similar to those seen in human beings who have already been primarily infected in the past, that is, bronchogenic tuberculosis. There is, however, no pathological evidence that this occurs in man; so far all the evidence supports the view that all human beings react to a primary infection with a primary complex, however insignificant it may be in some cases.

The term "allergy" is applied to the difference between the body's response to a second or later dose of antigen (the tubercle bacillus or its products) and its response to the first introduction of the antigen. It consists of both hypersensitivity and resistance. Rich and his co-workers in well-known experiments have shown that these two phenomena can be dissociated, but it seems possible that hypersensitivity, though not essential for resistance, may play some additional part in it. Allergy or hypersensitivity to the tubercle bacillus must not be confused with tuberculin hypersensitivity; this phenomenon appears to be unconnected with resistance, and its exact mechanism is still obscure.

The intimate mechanism of resistance to tuberculosis is still a matter for debate, particularly in regard to the role of cells. At all events no bactericidal power has been demonstrated in the serum of animals either naturally resistant or made so as a result of infection; and even those who do not believe that the cells, as such, play any role in resistance, agree that cells specially sensitized may so do.

Mr. R. E. Glover: Only a few aspects of immunity to tuberculosis have been selected for consideration.

#### (1) NATURAL RESISTANCE

If it can be established that certain breeds possess a natural resistance to tuberculosis, it might be accepted that races showing an enhanced resistance can be built up by a

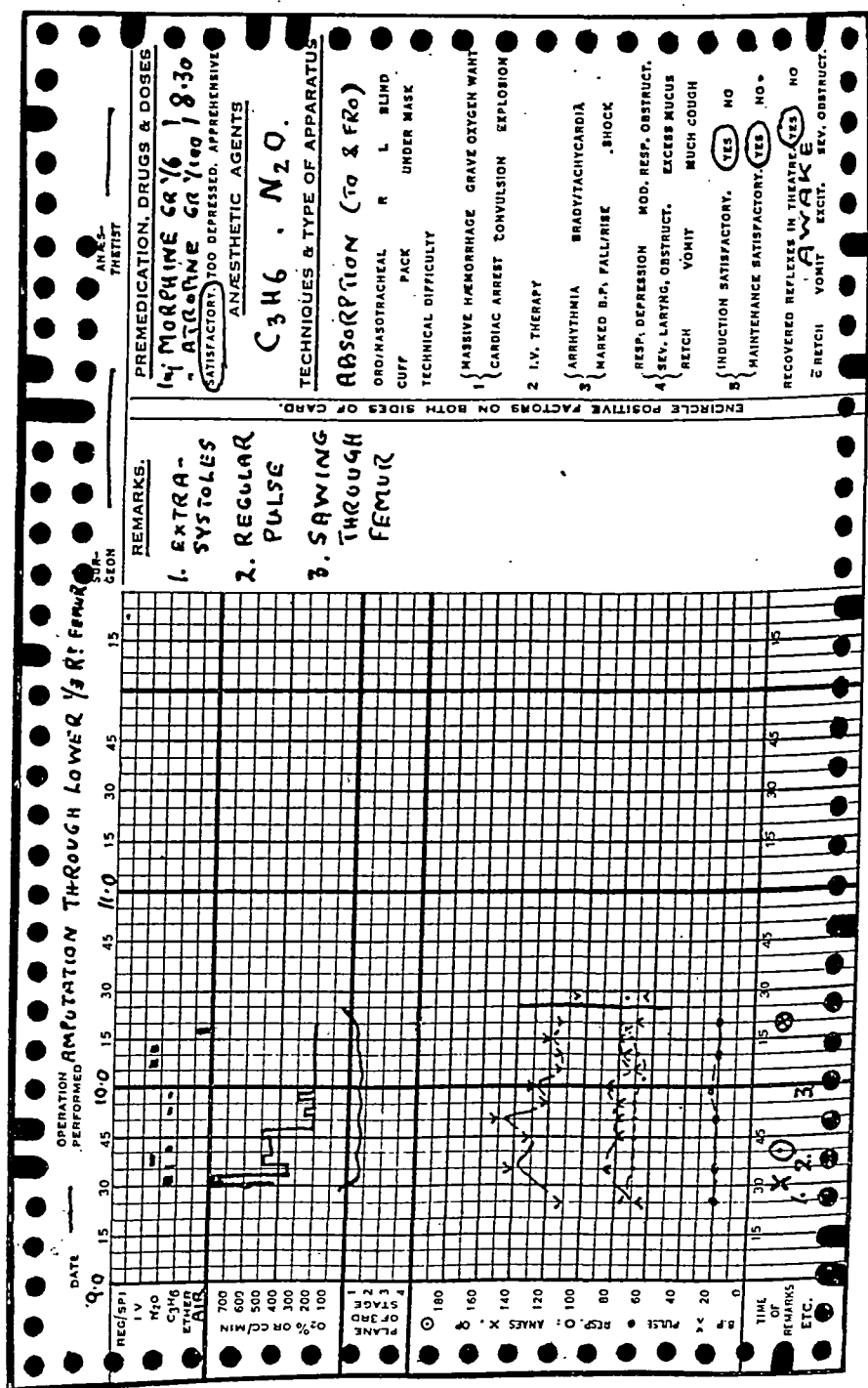


FIG. 2.

applied to tuberculo-immunity is based on this assumption. From this it follows that the most successful vaccine is likely to be one which, while it is completely innocuous, has a long period of retention in the body. There is, however, a tendency towards a fairly rapid elimination of aqueous suspensions: to avoid this drawback acid-fast organisms in a slowly absorbable liquid, as suggested by Vallée, have been used. It has been assumed that as certain oils, such as liquid paraffin and olive oil, are held in the tissues for long periods, so mixtures of these agents with acid-fast bacilli should be retained at the site of injection and thus induce a more prolonged immunity. The high hopes held by earlier investigators have not been fully realized possibly for two reasons. The first depends on the lethal action exerted by many of these oils on acid-fast bacilli, an action which is most inconstant and probably dependent on the type of oil and the route of injection. In many instances the organisms are inactivated fairly rapidly; as an example, it may be mentioned that when guinea-pigs are injected intraperitoneally with *M. johnei* in liquid paraffin, the recovery of the organisms is extremely difficult after as short a period as eight weeks. The second reason is related to the strong tendency on the part of the tissues of the host to enclose the inoculum in a firm fibrous capsule; as a result the beneficial immunizing influence which otherwise the organisms might be expected to exert, steadily diminishes.

Most of the available information on oily suspensions has been obtained in the guinea-pig although their effect has been demonstrated on calves (Buxton and Glover, 1934, 1939). These experiments suggest that living B.C.G. in oil is a less efficient immunizing agent than B.C.G. in saline suspension. In addition, these mixtures produce extensive local lesions which are not readily resorbed.

There is another consideration that although the organisms may be eventually killed and are also fairly quickly encapsulated, they are not necessarily held to the site of injection. It has been suggested that virulent strains which cannot be employed with safety if suspended in a readily absorbable liquid, might be used with impunity in an oily substrate. This is not the case since an examination of lymphatic glands nearest to the site of injection will show that, at any rate for a time, viable bacilli have escaped and have been carried to the nearest glands.

Although the premise that immunity to tuberculosis is necessarily dependent on the continued existence of living organisms in the body has been supported to a considerable extent by experimental evidence, it may be only partly correct in that immunity may persist in the absence of viable bacilli. We have shown in calves inoculated intravenously with B.C.G. (Buxton, Glover and Griffith, 1934) that the injected organisms disappear quite rapidly and are no longer recoverable in culture after a fairly short time: thus, although B.C.G. was readily isolated up to 25 days, after 71 days only one colony was obtained and at the 120th day, the organism appeared to have been completely eliminated. At this stage, however, the vaccinated animals possess a solid immunity which will persist for about twelve months. Nevertheless, as pointed out by Edwards (1942), the protection afforded by a single dose of living vaccine slowly wanes so that revaccination must be practised at fairly frequent intervals. This has certainly been the experience with B.C.G.

To ascertain the immunizing value of dead bacilli numerous experiments have been undertaken in the guinea-pig showing that killed suspensions will produce some degree of immunity which in a highly sensitive animal such as the guinea-pig, may be nearly as solid as that induced by living bacilli. In order to obtain clear results, it is necessary to give multiple injections of the antigen and to give a very small test dose so that the body defences are not swamped. Griffith and I found that guinea-pigs injected with tubercle bacilli killed in various ways (heat, formol, glycerol, &c.) showed some enhanced resistance which was nearly as effective as that induced by B.C.G.: nevertheless, this resistance was not of a high order and diminished the extent and severity of generalized lesions in only 50% of the animals (Griffith and Glover, 1939).

Dead organisms suspended in liquid paraffin or olive oil will give a level of protection to calves which is not very different from that induced by living B.C.G. in oil. These methods are unlikely to be of great practical value partly because multiple doses at very frequent intervals seem to be necessary, and partly because unsightly local lesions are prone to develop at the site of injection.

### (3) ALLERGY AND IMMUNITY

There is a school of thought represented by Rist and others which regards sensitivity to tuberculin as an indicator of immunity and considers that resistance cannot be separated from hypersensitivity. Another school supported by Rich *et al.* (1938) postulates that allergy and immunity are two distinct phenomena whose association in tuberculosis is entirely fortuitous. It is suggested that the hyper-allergic state is actually detrimental because if infection or reinfection occurs, there is a greater tendency for hyperæmic



process of selection. The development of this character in any of the larger mammals would be a long process, but in animals which breed rapidly, a division between relatively resistant and relatively susceptible strains might arise fairly quickly.

There are several indications that variations in susceptibility exist amongst members of the same type and Lurie (1941) made an exhaustive study of six inbred rabbit families which he exposed to tuberculous infection by natural contagion. Lurie found that the usual method of testing immunity by the inoculation of small doses of tubercle bacilli was unsuitable for the detection of slight differences in resistance. Accordingly the rabbits to be tested were placed in wire cages divided from a number of tuberculous animals by an open mesh partition. Infection was transmitted aerially and by infected urine and faeces, and the results were more illuminating than those obtained by the usual methods of infection.

We have no such exact evidence regarding the inherited resistance of larger animals, and the so-called natural resistance may be more apparent than real. Environmental conditions may play an important rôle. In general the horse, sheep and goat which are supposed to be more resistant than cattle, do not normally come into contact with the natural reservoir of infection, viz. cattle. The goat is quite susceptible to artificial infection, and the same is probably true of the sheep and horse; the dog is much more refractory to inoculation tuberculosis and may possess a true natural resistance.

In spite of the difficulty of assessing the influence of environment, there are some indications that certain races of cattle possess some degree of basal immunity. Carmichael (1939) has pointed out that in tropical Africa and Asia, almost all indigenous cattle are of the Zebu type, although there are areas where non-Zebu cattle occur. The existence of tuberculosis amongst native cattle appears to be low and lesions which are usually confined to the glands, are often calcified and of the non-progressive type. There are three possible explanations: (1) that tuberculosis is a rare disease in native cattle; (2) that the mode of life does not favour the spread of the disease; (3) that the infecting organism is of low virulence. Workers in India and Africa such as Sheather, Edwards, Carmichael, &c., have shown that the strains isolated from native cattle are equal in virulence to the usual European dysgonic bovine types. Carmichael, for example, found that 39 strains isolated from Uganda cattle were typically dysgonic and of normal virulence. This is an indication that the mildness of the disease is not due to strain differences and that the bovine bacillus does not undergo modification as a result of a sojourn in the tissues of the relatively resistant animal. Inoculation experiments in which Indian calves from supposedly resistant families have been injected with virulent tubercle bacilli have demonstrated the possession of an enhanced resistance.

The consensus favours the view that native cattle possess a higher resistance. Carmichael has reported that in Uganda the two main groups of cattle, viz. Zebu and Ankole, show a different incidence of tuberculosis. Over a period of five years, there were 0.8% of cases in Zebu breeds as compared with 25.9% in the Ankole. There is agreement amongst workers in Africa (Carmichael, Hornby, Cornell, &c.) that all native cattle are subjected to much the same management and are often crowded together under conditions which would favour the spread of the disease. It is unlikely, therefore, that an animal husbandry factor is responsible for the observed differences.

There is an impression that even in European countries some breeds are less susceptible to natural infection than others. It is not easy to obtain data, partly because of variations in environmental conditions. Recent surveys by means of the tuberculin test, have revealed areas in the British Isles in which the incidence of tuberculosis is generally low. It would be of interest to determine whether this is due to conditions which lessen the chance of exposure to infection or to an enhanced natural resistance. The possibility of effecting an improvement by selective breeding may not commend itself to the immunologist and sanitarian on account of the lengthy period before any appreciable result could be obtained, but if a long view is taken this aspect of tuberculosis control should not be ignored.

## (2) SOME ASPECTS OF INDUCED IMMUNITY

In attempted control of tuberculosis by inoculation, two main lines of investigation have been followed: (a) the use of living organisms in the form of an attenuated bacillus, e.g. B.C.G., or by a type which, while fully virulent for its natural host, is of insignificant pathogenicity for the animal to be immunized, e.g. avian tubercle bacilli in cattle, and (b) the use of dead products comprising inactivated suspensions of tubercle bacilli, &c. The general aspect of the employment of live vaccines was covered by Dalling, Matthews and others at meetings held during the previous session (1942). For a long time it has been considered that the highest degree of resistance is dependent on the continued existence of living organisms in the body and the whole concept of premunition as

applied to tuberculo-immunity is based on this assumption. From this it follows that the most successful vaccine is likely to be one which, while it is completely innocuous, has a long period of retention in the body. There is, however, a tendency towards a fairly rapid elimination of aqueous suspensions: to avoid this drawback acid-fast organisms in a slowly absorbable liquid, as suggested by Vallée, have been used. It has been assumed that as certain oils, such as liquid paraffin and olive oil, are held in the tissues for long periods, so mixtures of these agents with acid-fast bacilli should be retained at the site of injection and thus induce a more prolonged immunity. The high hopes held by earlier investigators have not been fully realized possibly for two reasons. The first depends on the lethal action exerted by many of these oils on acid-fast bacilli, an action which is most inconstant and probably dependent on the type of oil and the route of injection. In many instances the organisms are inactivated fairly rapidly; as an example, it may be mentioned that when guinea-pigs are injected intraperitoneally with *M. johnei* in liquid paraffin, the recovery of the organisms is extremely difficult after as short a period as eight weeks. The second reason is related to the strong tendency on the part of the tissues of the host to enclose the inoculum in a firm fibrous capsule; as a result the beneficial immunizing influence which otherwise the organisms might be expected to exert, steadily diminishes.

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There is another consideration that although the organisms may be eventually killed and are also fairly quickly encapsulated, they are not necessarily held to the site of injection. It has been suggested that virulent strains which cannot be employed with safety if suspended in a readily absorbable liquid, might be used with impunity in an oily substrate. This is not the case since an examination of lymphatic glands nearest to the site of injection will show that, at any rate for a time, viable bacilli have escaped and have been carried to the nearest glands.

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caseo-necrotic lesions to be produced and these are inimical to the health of the infected animal, whereas such reactions do not arise in the desensitized animal.

It is scarcely possible at the present time to reconcile these divergent points of view although most of the available evidence in small animals favours the second hypothesis. It is of interest to consider the reactions of larger animals, particularly cattle. If we take B.C.G. as the sensitizing and immunizing agent, we can arrange our experiments in such a way that allergy and immunity if not dependent upon one another, at least run a parallel course. In one series (Buxton, Glover and Griffith, 1934) groups of calves were vaccinated with B.C.G. at intervals of three, six, nine and twelve months respectively and were then tested by mouth with virulent cultures. Systematic tuberculin testing revealed a steady decline in skin sensitivity which was practically negative after twelve months; concurrently there was a fall in the power of resistance to infection. It appeared that the level of immunity and the sensitivity to tuberculin declined at about the same rate and this seems to support the first theory.

On the other hand experiments can be devised which appear to afford no evidence of any relationship between these two reactions of the tissues. In some long-term trials which have already been reported (Buxton, Glover, Dalling and Bosworth, 1939), a number of calves was vaccinated with B.C.G. at regular six-monthly intervals for three years during which time they were constantly exposed to infection. At the end of the period some were practically completely anergic while others were still reasonably sensitive to tuberculin. At post-mortem, however, it was impossible to correlate the extent of any lesions present with the allergy to tuberculin. In some instances animals which were highly sensitive showed the least degree of tuberculosis involvement, a finding which does not seem to support the theory of Rich.

In all probability the true position is represented by a middle course. In the present state of our knowledge we are not likely to be able to modify the course of tuberculous infection or to alter the duration or strength of an immunity induced by vaccination, by attempts at desensitization. Certainly in our subjects such a method would not be a practical proposition.

#### (4) CHEMOTHERAPY

Recently sulphanilamide (Rich *et al.*, 1938; Sjögren, 1942; Rist *et al.*, 1940); sulphathiazole (Bullon *et al.*, 1942); and particularly promin (Feldman *et al.*, 1942; Barach *et al.*, 1942), a sulphone derivative, have been assayed. According to Feldman and others, promin has given the most encouraging results. For example, in one experiment all the controls of a number of guinea-pigs infected with a small dose of virulent tubercle bacilli were dead at 224 days, whereas only 19% of a similar series treated with promin after infection, had succumbed: in the remainder the lesions were small and were resolving. The main difficulty at the moment seems to be the need for repeated doses of these drugs if any demonstrable effect is to be obtained, with the consequent danger of producing immediate or delayed toxic effects from the agent itself.

#### GENERAL REMARKS

In planning experiments on immunity to tuberculosis, too little attention has been devoted to the question of the route and weight of infection and the effects of frequent exposures. As far as possible natural routes should be followed in applying test doses, i.e. the alimentary or respiratory tracts should be attacked. In general, it is much more difficult to set up infection by the alimentary than by the respiratory tract. This difference in susceptibility is brought out in animals which are fairly refractory, such as the dog. Findel (1907) noted that dogs can be infected by 0.5 mg. of culture given by inhalation, whereas as large a dose as 172 mg. failed to infect by the alimentary tract. Experiments of the same type carried out in calves have led to similar conclusions. It must also be remembered that dosage may have a profound influence on the production of primary local lesions at the point of entry. Thus S. J. Edwards (1937) has shown that in calves, bucket-fed with tuberculous milk, the glands of the alimentary tract may entirely escape, whereas foci are found in the thoracic glands in every case. On the other hand we have shown that calves infected by single or repeated large doses given orally in a very small bulk, usually show extensive lesions of the mesenteric glands, with an occasional spread to other parts, including the thoracic cavity. It is possible that a restricted number of organisms entering a lymphatic gland may produce minimal lesions which are not readily detected and act as inducers of a local immunity protecting the tissues from further invasion. This factor may seriously complicate the interpretation of vaccination experiments.

A promising line of research lies in the production of pulmonary lesions by means of very fine particles in the form of mist as applied by Wells and Lurie (1941), in which

rabbits have been exposed to controlled numbers of tubercle bacilli sprayed into the atmosphere so that only the smallest droplets were carried in the air stream. When one thousand or more bacilli were inhaled, a widespread pulmonary disease was induced while multiple foci followed the introduction of as small a number as 23 organisms.

In carrying out immunity experiments, particular attention might be paid to such factors as the size and nature of the menstuum in which tubercle bacilli are suspended, the significance of tonsillar infection followed by lymphatic spread and the susceptibility of the lungs to particles of varying size.

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Dr. Robert Cruickshank asked: (1) whether in view of the known association between tuberculosis and malnutrition, there was any exact knowledge about the effect of a particular kind of diet in raising resistance to clinical infection; (2) what the present attitude was among tuberculosis workers regarding the use of B.C.G. or similar vaccine for the protection of children of tuberculous parents and of susceptible students and nursing staff.

Dr. E. Nassau: In reply to Dr. Cruickshank's questions (a) whether there is anything known of the influence of nutrition on resistance to tuberculosis, and (b) evidence in humans on the value of B.C.G. vaccination.

(a) There is a good deal of experimental and statistical evidence to prove the importance of first-class proteins in the diet. Experiments carried out on pigs before the last war and guinea-pig experiments of my own showed that animals kept on diets containing up to 16% first-class protein (in form of lactose-free casein) showed less extensive lesions and survived for much longer periods than the controls. Statistical data from Denmark during the last war, tuberculosis mortality records from German prisons during the last century showing a very marked decrease in mortality after improvements in the diet, mainly by addition of meat; and last, the increase of tuberculosis among inmates of mental hospitals during the present war in this country constitutes strong circumstantial evidence in favour of the detrimental effect of lack of first-class protein in the diet on resistance against tuberculosis.

(b) A well-controlled series of contact children were vaccinated with B.C.G. in Czechoslovakia with very encouraging results.

[March 24, 1943]

#### DISCUSSION ON IMMUNITY. IV.—IMMUNITY TO BACTERIA

Professor T. J. Bosworth: In a recent article Kolmer (1942) remarks that the efficacy of active immunization of guinea-pigs and human beings by the administration of plain and especially of alum-precipitated toxoids of *Cl. tetani* has now been so well proven as to require no comment or review of the literature. Much less investigation, however, has (he says) been devoted to the problem of active immunization of the lower animals and man against the principal Clostridia of gas-gangrene by their respective toxoids.

While the first of these statements can be accepted some sort of reply, if perhaps not an entirely complete one, can be made to the second. To find it one need only refer to the published records of the research institutes of this country and the Empire from which it will be seen that very encouraging results in the prevention of anaerobic infections of animals have attended the use of the respective toxoids more particularly in the form of formalin-treated fluid cultures.

The products now in use might be improved if they were subjected to the careful and precise methods of experimentation which have been lavished on the preparation of diphtheria and tetanus toxoids but the need for this has been less urgent as they have proved themselves to be better immunizing agents than plain or even alum-precipitated toxoids. In fact they have been found so useful in practice that it would appear to be a pity that they are not being used to the extent they ought to be as a measure of disease control in wartime when the supply of home-produced food of animal origin is an important factor in the nutrition of the population and its maintenance should be less subject than usual to purely economic considerations.

It would have been possible at the outbreak of war with a little organization to have ensured that these vaccines and the corresponding sera were more generally employed. The vaccines of this class which may briefly be considered are those of the *Clostridia chauvæi*, *septica*, *welchii* and *œdematiens*. As regards their efficacy it may be said in general terms that if losses from natural infection with one or other of these anaerobes were much in excess of 1% among vaccinated animals it would be suspected that the vaccine had not been properly prepared or administered.

To give a few examples:

Among 2,681 animals vaccinated against *Blackleg* no deaths occurred as against a figure of from 2 to 8% according to the district among the controls (Leclainche and Vallée, 1928).

The mortality from *braxy* among 25,202 vaccinated sheep was 0.75% against 10% or over in controls (Dungal, 1932).

Of 1,157 lambs born of vaccinated ewes 1.12% died of *lamb dysentery* against 13.09% of 2,530 control lambs (Dalling, 1928).

1.34% of 16,337 sheep receiving 2 doses and 0.49% of 4,888 receiving 3 doses of *œdematiens* vaccine died of black disease against 3.65% of 13,742 controls (Turner, 1936).

Mortality from *pulpy kidney disease* among lambs of 812 vaccinated ewes was 0.24% against 7.02% among lambs of 840 controls (Dayus, 1938). In another experiment 1.025% of 11,604 vaccinated animals died and 2.086% of 15,768 controls.

The superiority of formalized vaccines over the formalized filtrates previously used was first pointed out by Leclainche and Vallée (1925) and soon confirmed by other workers.

It was natural to assume that such vaccines owed their increased immunizing power to the fact that they contained a bacterial antigen in addition to toxoid and this question has been studied and with it the relative importance of invasiveness and toxicity on the part of the causal organisms in the production of disease.

This incidentally has raised another question, viz. the most suitable kind of preparation to use for the experimental testing of immunity resulting from the application of such vaccines.

Various workers have studied the antigens of *Cl. chauvæi*. Mason (1936) for example demonstrated (a) a toxin, (b) a heat stable antigen and showed that the former stimulates the formation of antitoxin whereas the latter does not do so. Animals immunized with toxin or toxoid may be resistant to the inoculation of living culture but as there is no correlation between the amount of circulating antitoxin in an animal and its power of resistance, the latter is due in part at least to the presence of soluble heat-stable antigen in the filtrate from which the toxoid is prepared. The heat-stable antigen alone, i.e. in the form of boiled bacilli, will confer strong immunity to the inoculation of living culture and it is probably the main antigen present in the vaccines which are commonly used to immunize animals against this organism. Since all *Cl. chauvæi* strains have the same "O" antigen the question of different types does not arise so far as immunity to this organism is concerned. Incidentally Mason found that the toxins of the four strains which he examined were also indistinguishable serologically.

In general *Cl. septique* produces a more potent toxin than *Cl. chauvæi* but like it has marked invasive properties. Whilst all strains produce one type of toxin, they are divisible into four groups on the basis of their "O" antigens. The latter fact should not be overlooked in the selection of strains for the preparation of vaccines since Henderson (1935) who used activated spore suspension as his test agent has shown that the immunity response to them is mainly an antibacterial one. A high level of antitoxic immunity is, however, effective against such an inoculum (Cradock and Parish, 1931) and it is well known to be capable of protecting animals against the injection of a virulent toxic culture.

Less attention appears to have been paid to the study of antibacterial as distinct from antitoxic immunity in the case of *Cl. œdematiens* but the superiority of formalin-treated culture to formal toxoid in immunizing animals against natural infection is accepted. Indeed there have been reports that formal toxoid does not seem to afford a very good protection against this organism. Some strains of *Cl. œdematiens* are predominantly

toxigenic and others predominantly invasive. Turner's black disease strains when isolated were of the former variety, but I remember handling one recovered from cattle which never yielded a measurable amount of toxin though it was highly virulent for guinea-pigs. While generally speaking one is inclined to the view that toxin of this organism is more important than the somatic antigen both contingencies appear to be covered by the use of formalin-treated culture as the immunizing agent.

As regards *Cl. welchii* types B, C and D which are the important animal pathogens of that group, it seems that their toxins are the important agents against which immunity is required. All three types produce conditions which are essentially toxæmic, and in which the causal organisms at the time of death are in many cases to be found only in the intestine. Since these organisms produce multiple toxins the important thing in immunizing animals against a particular type is to ensure that the vaccine used contains adequate amounts of toxoid corresponding to each of the toxins which that type is capable of producing. The conditions under which the cultures are grown is here important as influencing not only the amount but also the kinds of toxin produced. Then again instances have been reported of strains losing the capacity to elaborate a particular toxin after they have been subcultivated over long periods. Incidentally it may be mentioned that the possibility of a strain changing under natural conditions from one type to another by acquiring the power to elaborate an additional toxin has also been considered but no real evidence that this does happen has yet been obtained. As far as the group itself is concerned the possibility that there exist types which have not been recognized should not be overlooked. I have recently had under examination such an additional type isolated from a calf, and found that it produced a toxin which was not neutralized by any of the standard *welchii* sera corresponding to the four types originally described by Wilsdon.

The immunity response of animals to injections of *Cl. welchii* type B toxoid either alone or in the presence of bacterial bodies as in formalin-treated culture has been studied by Mason (1935) and shown to correspond reasonably closely to that established by Glenny in the case of diphtheria and tetanus toxoids. For example the quality of the toxoid used for primary or secondary stimuli determines to a large extent the immunity response of the animals and the effect of an adequate amount of toxoid at each dose is also apparent. Intraperitoneal injection of toxoid gave better immunity than subcutaneous.

Work on these lines might well be extended to other toxins of this group and to those of other anaerobes with a view to improving the methods of preparation and the use of a class of products which has already yielded satisfactory results in practice.

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Dr. W. Howard Hughes: Is vaccine therapy ever justified in the presence of established disease?

Gardner says:

"With regard to the vaccine treatment of already established infections it cannot be said that the procedure has been scientifically proved to have any curative value. "On the theoretical side it is difficult to see why a person who is already well 'dosed' with a living bacterial antigen should benefit from additional doses of the same substance in the dead state. A common explanation is that in chronic local infections the antigen does not circulate sufficiently to act as an efficient stimulus to antibody-production, and that the specific vaccine provides the necessary additional stimulus. There is, however, no proof of this; nor is it inherently very probable."

I want to show that the natural stimulus is inadequate and that the use of a vaccine can be supported both on experimental and theoretical grounds.

In certain diseases such as typhoid fever, bacterial endocarditis and syphilis, where a septicæmic stage of the disease occurs, there is adequate contact between the invading organism and the tissues and demonstrable antibodies appear in the blood. It was natural to assume that this held for *all other conditions*, but this is untrue, since once a lesion has become localized there is a failure in the absorption of the antigens necessary to provoke the body's response.

The difference in the mechanics between the fresh and the old lesion is indicated by Menkin's work. He has shown that if vital dyes are injected into the circulation they

will collect in the areas of fresh inflammation. If, however, the same thing is done where the lesion has become localized an exactly opposite result is obtained and the dyes fail to reach the inflamed part. There appears to be a barrier which acts in some respects as a semi-permeable membrane, and excludes from the lesion certain elements present in the blood-stream. This barrier acts even more effectively in the opposite direction to prevent, or at least to impede, absorption from the lesion into the body.

With staphylococcal lesions of the skin Fleming has shown that persons having repeated attacks of boils do not show any increase in antistaphylococcal immunity as compared with the normal population. This is not due to any defect in their ability to develop an immunity since they respond perfectly well to artificial immunization. This work is supported by the experiments of Hite, Banks and Dack, who found that cases with persistent sinuses from osteomyelitis also showed no rise of antistaphylococcal immunity unless they had received vaccines. They studied the actual absorption, not only in these natural sinuses but also in those artificially produced in animals, of various substances which would give easily recognizable responses in the body. They also used the same route in an attempt to administer protective doses of antitoxin.

The list of substances which are not absorbed from the localized lesion includes various vital dyes, particularly trypan blue, horse serum, typhoid and paratyphoid vaccines, staphylococci and their toxins, and Botulinus antitoxin. I understand that tetanus toxin is also excluded by developing connective tissue.

This barrier between the lesion and the body is only partial, since sulphonamides and other drugs go in and leucocytes and exudate come out. In an attempt to discover whether what is true for staphylococcal lesions is also true for other organisms, I have collected cases of pyelitis, selecting those where there were no complications and where the infection was limited to a single organism, and I have tested the patient's serum for agglutinins against the autogenous organisms.

Seventeen cases are set out in a table and the ages range from 22 to 76 years and the duration of symptoms from three weeks to many years. In twelve cases no trace of agglutination could be seen, the remaining five range from one in two to one in twenty-five, in no case was any higher result obtained. On the whole this supports the work on staphylococci.

#### RESPONSE TO ESTABLISHED URINARY INFECTIONS

Ages	Duration of symptoms	Agglutination	Organism
22	6/12	1/25	Coliform
23	3/52	0	Coliform
23	2/12	1/25	Proteus
23	1/12	0	Coliform
24	7/12	1/2	Coliform
24	3/12	0	Coliform
31	2/12	0	Coliform
36	2 years	0	Coliform
49	6/12	0	Coliform
53	years	0	Coliform
53	years	0	Coliform
60	years	0	Proteus
60	years	0	Coliform
62	years	0	Coliform
68	5/12	1/4	Coliform
75	years	1/25	Coliform
76	years	0	Pyocyanus

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Miss Muriel Robertson: In the protection of animals against infection with the anaerobic *Clostridia* there are two distinct mechanisms. Protection can be obtained experimentally on purely antibacterial lines and on purely antitoxic lines. In passive immunity certainly there was no summation of these two methods in experiments with mice in the case of *Cl. septicum* and unless an adequate amount of each type of antiserum was present the animals were not protected.

In the use of anaculture it seems to me that it has not been made manifest what is the actual rôle of the bacteria. The toxoid element is obviously successful as an immunizing agent as has been shown recently with tetanus toxoid in man, but it has not been demonstrated what part if any is played by the bacterial bodies.

When it is proposed to immunize with bacterial antigen alone in the absence of toxoid the amounts needed are always large and it is moreover necessary to take the serological varieties of the bacteria into account.

Sir Weldon Dalrymple-Champneys said that he thought the discovery of immune bodies in bacterial infection, because of their great value in diagnosis and their importance in

the prophylaxis of such diseases had tended to concentrate attention on specific immunity to the exclusion of non-specific or basal immunity. There might be some foundation for the popular belief that what was commonly called ill-health made people more liable to infection though there were, of course, well-known exceptions to this rule as for instance in the case of pneumonia. He hoped that in the future more attention would be given to studying the non-specific immunity mechanisms. It had been admitted in the discussion that the rôle played by particular specific immune bodies in certain diseases was far from clear and this was certainly the case in undulant fever in which the agglutinins which provided the best aid to diagnosis were sometimes completely absent though the specific organism could be isolated from the blood.

Mr. John Francis said it would appear that although a strong immunity can readily be produced against many toxins and viruses the production of an effective bacterial immunity was more difficult.

Bazely (*see Francis, J., J. Roy. Army Vet. Corps, 1943, 14, 73*) used cautiously heat-killed cultures of *Str. equi*, which had only been grown for a few hours and were heavily capsulated, to immunize horses against strangles. A statistically significant degree of protection was produced in a trial on large numbers of horses. In previous discussions the differences between the methods which can be adopted in human and animal practice had been emphasized, but whilst these differences undoubtedly existed there were very close similarities. Smallpox and fowl pox, rabies and equine encephalomyelitis, yellow fever and horse sickness or rinderpest, were all examples of human and animal diseases in which modified live viruses were successfully used.

[April 21, 1943]

## DISCUSSION ON IMMUNITY. V.—IMMUNITY TO VIRUSES

Sir John Ledingham (*Abridged*): The past two decades have seen enormous advances in our knowledge of virus diseases and of the nature of the causative agents. This new knowledge has greatly assisted fresh researches on the subject of our discussion but we have to go back to Pasteur, to Jenner, and even to pre-Jennerian days to find certain solutions of the general problem which have proved their value and are still to-day widely practised. In 1936, when opening a similar discussion, I referred to the shortcomings of inactivated virus as an immunizing antigen and to Jenner's discovery as "the touchstone by comparison with which all subsequent efforts in this sphere must be judged". The challenge, I believe, still stands. The fact is that there is no royal road to success in this sphere of endeavour and even the triumphs of Jenner and Pasteur offer plenty of scope for further inquiry with a view to betterment. The chief objective must always be the securing of as useful and durable a protection as possible, compatible with safety to the vaccinees, human or animal, and the avoidance of early or remote complications and sequels such as resultant carrier-states leading to fresh outbreaks by contact, insect transmission, or other ways. We have, in fact, to search for methods of inactivating virus which will ensure a residual antigenicity of the highest grade. This has proved no easy task and we may have to depend for many a day yet on the inherent tendency of viruses to develop less potent variants of themselves which prove to be endowed with unexpected properties suitable for exploitation. Pasteur started this hunt with his experimental work on rabies and it still goes on. Though safety should be a main objective, I have a good deal of sympathy with a statement by Soper at the International Microbiological Congress in New York in 1939 when talking about yellow fever vaccine. He said: "Immunity must probably be bought at a price and a careful study should now be made to obtain a vaccine of high antigenicity even though it carries a certain wallop for some of those vaccinated." Two principles only have been, and still are being, exploited for vaccine purposes, viz. (a) the "living" or active virus of a derived variant strain or an immunologically cognate strain, and (b) the original or variant strain after it has been completely or partially inactivated in a variety of ways.

I shall allude also to a third source, so far but little exploited in the field. This is a combination of the active virus against which protection is sought, with another virus not necessarily related (interference principle, so-called).

Jenner.—In my Presidential Address to this Section (*Proc. R. Soc. Med.*, 1935, 29, 73) some years ago I gave reasons for the belief that cowpox, which is still with us, was a virus *sui generis* belonging to the great family of pox infections. Recent experimental work by Downie has confirmed this belief. Before Jenner's day variolization most probably owed what success attended its use to the fact that by arm-to-arm passage a skin-adapted variant much less potent than the original had been evolved. We know, for example, that vaccinia which has long been cultivated in the dermis can lose its capacity



to grow on the scarified skin. Cultivation of vaccinia in tissue or in the embryo chick membranes has now provided us with bacteria-free vaccines which have been used in practice with some success, but there is considerable evidence that a loss of antigenicity is apt to occur after long passage. A similar phenomenon has been noted with certain other cultivable viruses such as that of yellow fever. It would be very desirable to secure an inactivated vaccinia for smallpox protection if only, perchance, to avoid the risk of that rare but serious complication, post-vaccinal encephalitis, the aetiology of which remains obscure. The argument is still strongly in favour of infant vaccination which is only extremely rarely followed by this serious sequel.

*Rabies and the recent work of Webster of the Rockefeller Institute.*—Webster has done important work in the course of an attempt to improve rabies vaccines either for the post-infectious treatment of bitten persons or for the protection of dogs (see his book "Rabies", The Macmillan Co., New York, 1942). He has devised a new protection test in the mouse for the assay of rabies vaccines and has elaborated a new virus vaccine which has been rendered inactive by irradiation with ultraviolet light but which retains in full measure an antigenicity corresponding to the number of minimal lethal mouse doses in the material before inactivation. This number must be adequate and very carefully evaluated. The new vaccine, he claims, has given results in experimental trials far superior to those hitherto recorded in protocols which he has carefully scrutinized since Pasteur's day. We do not know how susceptible man is to rabies in the absence of treatment, and whatever the treatment may have been, the percentage mortality remains fairly constant in the neighbourhood of 0.2%. It is most desirable, therefore, as Webster says, to continue research on improved lines so that a bitten person undertaking a course of treatment may have some real assurance that his chances of contracting rabies will be negligible. It will be agreed that this matter of the antigenic content of virus vaccines must always demand the fullest consideration if we are to achieve results comparable in so far as grade and duration of immunity are concerned, with those that follow as a rule, but not consistently, recovery from the active virus infection.

*Poliomyelitis.*—Recent work in America showing that certain strains of this virus have been communicated to the cotton rat, the mouse, and the hamster, is of very great interest and the claim has been made that the hamster-adapted strain has been given to monkeys which have tolerated it well and have subsequently proved themselves immune to the normally virulent monkey poliomyelitis of human origin. Developments in this line of inquiry will be eagerly awaited.

*Inactivated or partially inactivated virus vaccines.*—These have been tested experimentally or in the field in a variety of virus infections, e.g. equine encephalitis, psittacosis, foot and mouth disease, dog and ferret distemper, rinderpest, influenza, swine fever, &c., and the inactivating agent used has been, for the most part, formalin. Where these vaccines have been evaluated by field trials, they would seem to have given good service but the methods used in the preparation of the vaccines and in the process of inactivation must be kept constantly under review in the experimental laboratory.

*The interference principle.*—A virus which is normally highly virulent for a particular animal and against which protection is sought, may fail to exercise its usual effect if administered in combination with another virus (or possibly a bacterium) of lesser potency but to which the host is also susceptible. Instances of this phenomenon have recently been recorded from the experimental laboratory but the mechanism or mechanisms to which the inhibitions are due, in particular cases, are not yet precisely understood. Two examples from this field may be mentioned. In the control of fowlpox, mixtures of fowlpox virus and pigeonpox virus have been used as the immunizing agents, while in the control of yellow fever (and incidentally of smallpox) Peltier and his colleagues in Senegal have employed with success a mixture of neurotropic yellow fever virus and ordinary vaccine lymph applied to the scarified skins of the native population (see *Bull. Acad. Med.*, 1939, 121, 657, and 1940, 123, 137). It is claimed that no troublesome sequels resulted. There are other important sides to this question of securing protection against virus infections but I can mention here only two of them.

*The virus-neutralizing antibody.*—I think the evidence as a whole supports the view that immunity to viruses depends, in the end at least, on the play of humoral influences either already mobilized or made quickly serviceable by an accelerated response on the part of the sensitized reticulo-endothelial tissue. When the virus-neutralizing antibody appears in response to active immunization or rises from a low to a high level, can we take the level reached as a guide to the host's power of resisting attack should he become exposed? This problem has received much attention of late in connexion with the active immunization of human beings against influenza. There would seem to be general agreement among experienced workers in this field that it would be dangerous to assume any direct proportionality between antibody-level and potential resistance. There is in fact evidence that persons with high antibody-levels may on occasion prove

susceptible to attack. Only extensive field trials will clarify this problem. Dr. Thomas Francis of the University of Michigan, in the course of a recent survey of the problem of securing immunity to influenza, discusses the matter of the antibody-level as a guide to resistance but draws attention to the probably greater importance for defence of those more readily available protective mechanisms at the local site of attack of virus on respiratory epithelium. Of these local mechanisms he would particularly emphasize the importance of the virus-inactivating substance present in the nasal secretions. He had noted an enhancement of the virus-inactivating capacity of the nasal secretions of those persons whose antibody-titres had risen promptly in response to vaccination (*Personal communication*, see also his paper in *Science*, March 12, 1943).

Dr. C. H. Andrewes has stated that in the search for influenza virus variants that might be used in the active state for vaccination purposes none so far has been found possessing "the necessary combination of negligible virulence and good immunizing power".

Some viruses such as fowlpox and psittacosis normally give rise to little in the way of neutralizing antibody. Nevertheless, in the case of fowlpox, support for the humoral defence has come from the result of an interesting experiment by Goodpasture who grafted skin from immune birds on the chorio-allantois and found it to be quite susceptible *in situ* to fowlpox virus. When such grafts were regrafted to the immune bird they again became promptly insusceptible to experimental infection.

In a neurotropic virus disease (equine encephalitis) it has been shown by Olitsky and his associates that lack of virus-neutralizing antibody in the cerebrospinal fluid of vaccinated rabbits renders the animals susceptible to the virus when given intracerebrally. The titre of neutralizing antibody in the cerebrospinal fluid, when such antibody is demonstrable there in response to vaccination, bears a fairly constant relation to that in the blood, of 1:300. Consequently, if immunity to intracerebral inoculation of the virus is sought, it is necessary to have a high level of antibody in the plasma. This, he states, can be achieved by pushing the doses of formol-virus.

Neither the mechanism of action nor the nature of the antigen that gives rise to neutralizing antibodies is precisely known. Of the various fractional antigens of vaccinia virus which have been so far investigated, none has been found, on immunization, to give rise to this antibody. According to Rivers and his colleagues, serum obtained in response to infection by the active virus and thereafter absorbed with the LS antigen-complex and other known fractions, is still capable of neutralizing the active virus.

It has perhaps been too readily assumed that long persistence of neutralizing antibody in the blood, e.g. after recovery from yellow fever connotes a carrier-state. Far more concrete evidence on this general question is desirable than is at present available. In experimental psittacosis, at any rate, the work of Bedson on this particular point is highly illuminating.

*Virus reservoirs.*—The second issue I propose to mention and one of considerable importance to our study of methods of immunization, is concerned with the new knowledge that has been accumulating on the harbouring of virus agents by apparently healthy animals in nature. Study of the immunological relationships between virus and host in conditions that approach that of a true symbiosis, may well afford us valuable hints in our quest for improved methods of active immunization. We know, for example, that apparently healthy vampire bats may convey rabies to man and beast in Trinidad, that many avian species may carry psittacosis or psittacosis-like viruses, that neutralizing antibodies for the St. Louis and the equine encephalitic viruses may be found in the sera of normal fowls, horses and other mammals of endemic areas, while the virus of lymphocytic choriomeningitis has been recovered from wild house mice. A statement by two American workers (Howitt and van Herick) respecting these "barnyard" animal reservoirs of equine and other encephalitic viruses, is worth quoting: "Given a certain combination of conditions, weather, presence of biting insects, and appropriate hosts, apparent or inapparent encephalitis may develop in the locality. If one or more factors are absent the disease may lie dormant and only appear if the balance of nature is altered. A certain conditioning or tuning-up among the animal population may be necessary before man is to be infected" (*J. inf. Dis.*, 1942, 71, 179).

Much was said about possible animal reservoirs when encephalitis lethargica prevailed during and after the first world war and we may yet discover its origin in an animal source (see Reps. on Pub. Health and Med. Subjs., Min. of Health, No. 11, 1922, pp. 29-32).

To conclude, I think there is no doubt that considerable advances have attended our efforts in recent years to secure protection against virus diseases by methods which take the fullest cognizance of the safety factor but we have yet much to learn regarding not only the agents most appropriate for virus-inactivation in particular cases but also regarding the quantitative evaluation of the antigen to be administered, in terms

of measurable units. The position will doubtless improve with further improvements in methods of recovering virus from associated tissue. We may perhaps look forward to the provision by the biochemist and the biophysicist of the purified virus nucleoprotein for wide-scale biological experiment.

**Mr. T. M. Doyle:** *Crystal violet vaccine against swine fever.*—The use of crystal violet in the preparation of vaccine against swine fever (hog cholera) was introduced by Dorset, Bureau of Animal Industry, U.S.A.

The vaccine is prepared by inoculating pigs with swine fever virus, bleeding them out at the height of the temperature reaction, usually about the sixth to seventh day, defibrinating the blood and adding crystal violet and disodium phosphate. The mixture is then incubated for fourteen days at 37° C.

Tests have shown that the virus contained in the vaccine is inactivated after incubation for seventy-two hours, so the routine method of incubating for fourteen days provides a wide margin of safety.

*Establishment of immunity.*—A minimum period of twelve days must elapse after vaccination before immunity is fully established. This is one of the weak points of the vaccine, as it means that in practice it can be used only on swine-fever-free herds. Tests carried out at Weybridge have shown that serum can be given five days *before*, or five days *after*, the vaccine without interfering with its antigenic value. But when vaccine and serum were given simultaneously active immunity was not established.

*Immunity.*—Details of the potency tests made on the various lots of vaccine prepared cannot be given here so a summary of the results obtained with 12 vaccines is given in the following table:

Batches of vaccine tested	Number of pigs vaccinated	Doses of vaccine			Remained normal	Results		Virus controls	
		10 c.c.	5 c.c.	2 c.c.		Reacted	Died	Number inoculated	Died
4, 5, 6, 7, 9, 10, 11, 12, 13, 15, 20, 22	206	132	39	35	198	3	5	80	80

As the main object of these tests was to determine only whether repeated lots of vaccine of a reasonably uniform potency could be prepared, the vaccinated pigs were tested for immunity by the inoculation of virus, between the twenty-first and sixtieth day after vaccination. Three pigs showed slight to moderate reactions and five died, giving a total adequately protected of 97%.

*Duration of immunity.*—The duration of immunity has been tested on 60 pigs at intervals of seven to twelve months after vaccination. These pigs were divided into four groups and each group was treated with a different lot of vaccine. In some cases the immunity was tested against the inoculation of virus and in others against continuous contact with an infected animal. One vaccinated pig died and apart from a couple that were dull for twenty-four to forty-eight hours, the others remained normal.

**Dr. C. H. Andrewes** said he was much intrigued by the "interference phenomenon", and wondered whether it could not explain some facts usually thought to be covered by more orthodox immunological theory—for instance the protective effect of vaccination subsequent to exposure to smallpox. Work throwing some light on the mechanism of the interference had lately been published by Delbrück and Luria (*Arch. of Biochemistry*, 1942, 1, 111 and 207). They found that of two phages active on a strain of *B. coli*, one could completely suppress the growth of the other; the experimental results were interpreted as meaning that one phage particle could completely engage a key-enzyme in the bacterium necessary for multiplication of either phage or the bacterium itself. Phage inactivated by ultraviolet light was also able to block the growth of the other phage.

**Dr. D. McClean** remarked that with some virus diseases it is apparently necessary to produce the specific lesions in order to obtain immunity. In the case of vaccinia, working with a living elementary body suspension injected intracutaneously Henderson and he (*J. Hygiene*, 1939, 39, 680) had obtained a very disappointing immunity unless a vaccinia vesicle was accidentally formed at the point of needle puncture. If such a vesicle formed the resulting immunity was practically 100%. The same virus preparation applied by scarification produced 100% immunity. Intracutaneous injection was followed by some proliferation of the virus as shown by the development of a local nodule and axillary adenitis. Goodpasture and Buddingh (*Amer. J. Hyg.*, 1935, 21, 319), working with a cultured virus applied by scarification which produced typical vesicles, also obtained satisfactory immunity, but Rivers, Ward and Baird (*J. exp. Med.*, 1939, 69, 857), also using a cultured virus injected intracutaneously and taking special precautions to avoid accidental vesicle formation, only obtained immunity in about 25% of their series of children. Dr. McClean understood that a somewhat similar state of affairs existed in the immunization of experimental animals against influenza virus.

## Section of Odontology

President—B. MAXWELL STEPHENS, L.D.S.E.

[January 25, 1943]

### A SYMPOSIUM ON FACIAL RESTORATIONS

#### I.—Intra-oral Prosthesis in Bilateral Harelip and Cleft Palate

By J. W. MANSIE, M.R.C.S, L.R.C.P., L.D.S.

BILATERAL harelip and cleft palate frequently result in a particular facial deformity. The upper lip is short and tightly pressed against a deficient and underdeveloped maxilla. The lower lip is full and the condition is often aggravated by a close bite which brings the lower lip further forward. In most cases, but not all, the lip has been repaired and operations performed on the palate. The aim of treatment is cosmetic but at the same time an obturator may be made and the area of mastication increased.

On examining the mouth one finds that the upper anterior teeth are either missing or are lifted high up out of occlusion so that when the mouth is closed there is a considerable space between the lower incisors and the upper teeth or alveolus. The upper teeth are irregular and bunched together so as to lie inside the lower arch and, excepting perhaps the last molars, out of occlusion with it. It often happens that to get any teeth to meet, the mouth must be closed to such an extent that the lower lip overlaps the upper. To arrive at a satisfactory æsthetic result the upper lip requires to be pushed forward by a prosthesis carrying artificial teeth in normal relationship with the lower incisors. Also the bite must be opened and usually some plastic surgery is necessary on one or both lips. In order to make the upper lip sufficiently mobile an epithelial inlay is inserted to deepen the sulcus between the lip and the jaw, and in this space the prosthesis is put.

Two points in the construction of the prosthesis will be considered. First the means of attaching it in the mouth and second the use of acrylic resin.

Adequate retention of the prosthesis is essential because there is a very strong downward and backward thrust exerted by the lip. Since the bite is opened and the artificial incisors brought forward and downwards the natural teeth are covered by the apparatus. The natural teeth, by reason of their shape and position, rarely afford sufficient retention when the ordinary methods are used. A simple form of spring lock is required which can be manipulated by the patient and will not require frequent adjustment.



Three forms of such locks are illustrated. The first consists of a stainless steel wire attached to the prosthesis and approaching the natural tooth from above in the manner of a Roach clasp. The end of the wire turns in and fits in a pit in an amalgam filling or inlay. An inlay is preferable because the edges of an amalgam pit wear. In the second a platinized gold wire fits in a slot cut in an inlay, and in the third the wire from the prosthesis fits in a slot cut in an orthodontic pinch band. This forms a very satisfactory means of retention.

The use of acrylic resin in all except the metal parts of the prosthesis simplifies several difficulties. It results in a light prosthesis, additions are made easily and the material takes a high polish and remains clean.

Owing to the short upper lip and the relative absence of shadow from it, porcelain teeth usually look obviously artificial in these cases; acrylic teeth, however, appear very natural. There is no difficulty in attaching these teeth to the plate and very thin veneers can be made. The locks can be completely covered by the plate and acrylic teeth and then made accessible for adjustment by drilling a hole through the resin.

This material is also of great help in many of the other problems of facial prosthesis.

## II.—Facial Restorations

By E. MATTHEWS, Ph.D., M.Sc., A.R.C.S., L.D.S.

### INTRODUCTION

THE majority of civilian cases needing extra-oral appliances are those where the nose, ear or orbit is involved. Such cases, nearly thirty, have come principally from the Christie Cancer Hospital and the Manchester Hospital for Skin Diseases. Lupus, rodent ulcer, carcinoma and congenital absence of the ear are the usual conditions leading to the request for prosthetic restoration. Three cases involving loss or absence of fingers have also been treated. Dr. Ralston Paterson, Director of the Christie Hospital, has given active encouragement to this work and to the development of a restorative service for those patients who are unable to benefit from the skill of the plastic surgeon. Dr. P. Gabarro, plastic surgeon at the Christie Hospital, has welcomed the provision of temporary restorations for certain of his patients while they are awaiting the further stages of plastic reconstruction. This minimizing of the defect is much appreciated by the patient.

*Requirements of suitable restorative materials.*—(1) Lightness in weight. (2) Stability to light and heat and absence of irritant properties. (3) Washability. (4) Natural appearance. (5) High flexibility, to permit of sympathetic movement with the underlying tissues.

*Materials employed.*—A wide variety of materials have been used; vulcanite (Ottofy [1]), aluminium, electro-deposition of silver on gold foil base (Kazanjan [2]), celluloid (Pont and La Pierre [3]), gelatin-glycerin mixes (Batson [4], Bercowitsch [5], Lederer [6], Zinsser [7]), acrylic resins (Munson and Heron [8]), rubber latex (Bulbulian [9], Clarke [10], Matthews [11]).

The problems outstanding in this type of work are those concerning the suitability of various materials in relation to the proclaimed needs. While both metal and gelatin-glycerin mixes still continue to be used in certain quarters, recent progress is concerned with the use of acrylic resins as rigid restorations, highly plasticized acrylic resins as semi-rigid restorations and rubber latex as non-rigid restorations. Opinions naturally differ as to the best material but in my view, having examined a wide range of synthetic rubbers and related plastics, both in the laboratory and clinically, the best material to date on all counts is rubber latex. With nasal restorations in particular, where there is appreciable movement of the underlying tissues, the high mobility of the very thin edges of the latex appliance gives it a marked superiority functionally as well as æsthetically over the thicker edges of the semi-rigid plastics.

The one real limitation of rubber latex is the tendency to "age" which manifests itself on exposure to sunlight and to grease. Some loss of elasticity and change of colour therefore gradually develop. Since it is possible to pour up a series of prostheses for a given case without harm to the plaster moulds, the latter can be kept for several years and further specimens sent to the patient on request. Patients have been supplied with appliances from the same mould over a period of three years at the rate of three every six to twelve months.

*Mode of attachment.*—Where possible, use is made of available undercut surfaces to aid in the retention of the appliances but in addition the edges are sealed to the tissues with an adhesive; at present spirit gum is used. When carefully done the thin flexible edges of the appliance blend perfectly with the adjacent tissues. Patients are advised to wash the appliance in soap and water and to remove, periodically, any hardened adhesive remaining, using the finger-nail or thin knife blade.

(See illustrations on opposite page.)

My best thanks are due to Professor F. C. Wilkinson, Dean of the Turner Dental School, University of Manchester, where the development work has been carried out and to Mr. C. G. Dixon who has rendered able assistance during the last twelve months.

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FIG. 1



FIG. 2



FIG. 3

### III.—Prosthetic Appliances: A New Method of Fixation

By HAROLD ROUND, M.D.S., L.D.S.

AFTER experimenting over many years with various materials for the construction of prosthetic appliances and in the fixation of such appliances, my conclusions are: it is desirable (i) to use a material which lends itself to varying degrees of hardness and softness where required, (ii) to give greater permanency as regards durability and colour and better facilities for varying the colour and so obtain perfection of imitation of surrounding parts, (iii) to provide some better and more permanent method of fixation, if possible without the use of secondary or additional anchorage such as glasses.

To this end in the making of prosthetic appliances, a material known as Portex attracted my attention and research. The results so far have been pleasing, and have given in many cases an almost perfect imitation of Nature.

A new method of fixation of prosthetic appliances has been devised which has proved extremely satisfactory and effective, and although this experimental work is still young it promises to open up an entirely new field in methods of fixation of various extra- and intra-oral restorations, as well as other restorations.

Mr. J. N. Sankey has given me kindly and enthusiastic co-operation in devising and carrying out the necessary procedures in plastic surgery to enable these restorations to be worn without any external fixation. In order to establish continuity with surrounding tissues a little gum mastic is applied to the edges of the appliance although this is in no way necessary for fixation purposes.

The new methods devised and used for fixation of prosthetic appliances are as follows:

(1) *For the fixation of an artificial ear* (hitherto a most difficult prosthesis to fix with any reasonable degree of stability)—two tube grafts were made, one above the meatus and one below (fig. 1, A, B (Plate), C, D).

A small vulcanite base was made having a soft vulcanite hook at its upper part and a soft vulcanite projection or spur at its under part, the hook fitted over the top tube graft and the spur under the lower tube graft. Or this lower projection may take the form of a saddle in soft Portex which rests on the lower tube graft, thus distributing the weight evenly over the two tubes. In addition the vulcanite base carries a soft vulcanite tube which fits into the meatus and acts as further support for the base.

On to the vulcanite base the ear, made in Kallodent, was constructed, thus making the prosthesis in one whole part. We now construct the base in hard and soft Portex and the ear itself is constructed in the same material.

The patient is able to fix and unfix the artificial ear with great ease, and when in position it is quite firm and comfortable.

(2) *For the fixation of an artificial nose*. Three small pockets lined with Thiersch grafts were made, one in the position of the bridge of the nose and one each side just internal to the alæ nasi, the skin being applied in the usual manner on small compo moulds and sutured in position. A tube graft may be used instead of a pocket in the bridge of the nose. When the pockets were ready a small triangular device was made in acrylic resin carrying three projections to fit the pockets, the upper projection operating separately on the lower framework, the centre wire being loaded with a very fine spring, so that the upper projection could be collapsed to a small extent against the lower projections before insertion, and when in position the spring under very slight pressure forced the projections into place causing the framework to be firmly stabilized. The framework carried two horizontal trumpet-ended tubes to receive two pins attached to the back of the nose into which the nose, constructed in Kallodent, was fixed (fig. 2, A, B, C, D (Plate)).

#### NOTICE TO READERS.

A full report of the discussion on "The Treatment of Pulpless Teeth" held on November 23, 1942, has been prepared and is available to readers in the Society's Library; a short report of the meeting was published in the *Proceedings*, February 1943, 36, 181.

In future, full reports of other papers read at meetings of this Section which are published only in abstract will also be deposited in the Library.





PLATE I.



FIG. 1 B.—Colour photograph, showing side view of Portex ear in position.



FIG. 2 D.—Colour photograph showing side view of Kallodent nose.



FIG. 1 A.—Showing upper and lower tube grafts.



FIG. 1 C.—Back view of ear in position.



FIG. 1 D.—Base of ear showing hook and spur with ear attached.

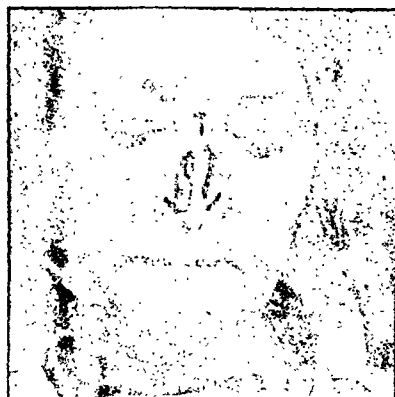


FIG. 2 A.—Showing the three pockets, dark pins placed in pockets to demonstrate position.



FIG. 2 B.—Fixation appliance in position, showing the projections fitting into their pockets: spring-loaded pins from upper projection on upper part of framework, and the trumpeted horizontal tubes to receive fixation pins on nose.



FIG. 2 C.—Front view of nose, constructed in Kallodent, in position, and being worn without external fixation.

**HAROLD ROUND:**  
*Prosthetic Appliances. A New Method of Fixation.*

[February 22, 1943]

## Pulp Reactions to Dental Cements

By E. B. MANLEY, B.D.S., L.D.S.

(From the Research Department of the Birmingham Dental School)

### INTRODUCTION

In 1940 an investigation was carried out into the effects of various filling materials on the human pulp (Manley, 1941). The results showed that silicate cements produced marked degenerative changes in the pulp tissue, and that the reaction set up under a cavity filled with a copper oxyphosphate cement was one of great severity.

It was, therefore, considered necessary to carry out a further investigation on similar lines into this group of cements as a whole in order that more definite conclusions could be arrived at with regard to the widely discussed biological question of their action on the pulp.

During the last eighteen months 106 operations have been carried out on human teeth, 68 of which were concerned solely with dental cements.

Depending on the composition of the powder, the group consists of three main types: (1) Zinc Phosphate Cements. (2) Copper Phosphate Cements. (3) Silicate Cements.

Certain cements claiming to have special germicidal properties are mainly zinc phosphate cements with either a salt of copper or a silver salt added to the powder with the object of rendering the cements germicidal in the mouth (Skinner, 1936). In each type, however, the liquid employed consists mainly of ortho-phosphoric acid with certain modifiers which control the setting time and minimize heat generation. When in a plastic state, these cements are known to be highly acid, and if we take into account the biological factors involved in their use it would be reasonable to suppose that any changes in the pulp would be manifest in a very short period of time, especially in young teeth whose dentine is highly permeable. A series of experiments, therefore, has been carried out to ascertain the changes that occur in the pulp twenty-four to forty-eight hours after the insertion of the cement into the cavity.

In two previous investigations (Manley, 1936 and 1941) concerned with other filling materials, the minimal changes that were observed occurred under cavities filled with zinc oxide and eugenol. The effect produced by the cutting of the cavity was not assessed, although care was taken to reduce traumatic stimuli to a minimum by the use of a geared-down handpiece. It has been observed that if a cavity is cut rapidly with a sharp bur and the tooth extracted at once, changes occur in the pulp. In the present investigation, therefore, it was decided to obtain a control by preparing a cavity with a 'slow-running' bur and filling it with some inert substance. This was covered with a celluloid cap and sealed to exclude mouth fluids and extracted after twenty-four hours had elapsed. Any changes that occurred could be regarded as a minimal reaction and used as a base line in assessing the effects of any other filling material over a similar period of time. The substances chosen for the purpose of control were (a) cotton-wool impregnated with olive oil and (b) dry asbestos fibre.

### DISCUSSION

History reveals that pulp irritation by the acid of the cement liquid has always been regarded as a dangerous possibility. In experiments on dogs Gurley and Van Huysen (1937) found that if a cavity near the pulp was filled with a cement whose liquid is phosphoric acid a reaction occurred, but if a similar cavity is filled with the same cement, eugenol being substituted for the phosphoric acid, no reaction took place. Undoubtedly all cements are acid while setting, yet in reports on this subject that have been published from time to time it seems that more significance has been attached to their pH values when fully set (Worner, 1940). The surface acidity of dental cements at the time of insertion into the cavity has recently been investigated (Warren Harvey, 1943). It was found that of 45 cements tested only 5 showed a surface pH above 2. This confirms the spot tests carried out by the author and Dr. Thorpe in the Biochemistry Department of the Birmingham University. With the exception of gastric juice, the reaction of the tissues and tissue fluids of the body is nearly neutral. It is known that the tissues are very sensitive to the reaction of the fluids bathing them, and slight changes in

reaction may have a profound physiological effect (Thorpe, 1938). Therefore, the initial high acidity of these cements at the time of insertion into the cavity is a factor to be seriously considered, especially when used on young dentine which is highly permeable and would permit the easy passage of any chemical irritant to the pulp.

In clinical practice the protective reaction of the pulp under carious dentine must be taken into account. This has been previously described by Fish (1932). On the degree of extension of the cavity beyond the carious limits will depend the number of new and healthy tubules opened up and directly exposed to the action of the newly mixed cement. In the present investigation, where cavities have been cut in sound teeth, the pulp will have received the maximum degree of irritation in relation to the size of the cavity. Patients of ages varying between 10 and 16 were selected in whom the extraction of the premolars was required for orthodontic purposes. The same technique of cavity preparation was adopted as on previous occasions. After extraction the teeth were fixed, decalcified and embedded in paraffin. Serial sections were then cut and stained with hæmatoxylin and eosin, and Van Gieson. Heidenhain's stain was also used to show nuclear changes.

*Pulp changes.*—It will be seen that the changes in the pulp in the less severe reactions are confined to the odontoblast layer and are restricted with mathematical accuracy to that part of the layer beneath the cavity. In the more severe lesions the surrounding pulp tissue shows inflammatory reactions. In some instances the irritation is so intense that the classical signs of acute inflammation are observed. Nuclear changes, karyorrhexis, karyolysis and less frequently pyknosis characteristic of necrosis can be identified.

*Controls.*—The changes occurring in the pulp under a control cavity filled with dry asbestos fibre and sealed in for forty-eight hours (figs. 1 and 2) are confined to those



FIG. 1.  $\times 65$ .—Changes under control cavity filled with dry asbestos fibre. T.—Tract of tubules under cavity. D.O.—Normal odontoblasts above cavity on opposite side of pulp.

cells of the odontoblast layer whose fibrils have been cut. The lateral processes or collars of the odontoblasts have been broken and many cells, having lost their fibrils, are scattered and dragged away from the dentine surface. No inflammatory changes have occurred in the pulp tissue which is normal in appearance. Fig. 3 shows the disturbed odontoblast layer under the deepest part of a cavity filled with cotton-wool soaked in olive oil and sealed in for forty-eight hours. No inflammatory reaction has occurred in the pulp, the changes again being confined to the cells of the odontoblast layer.

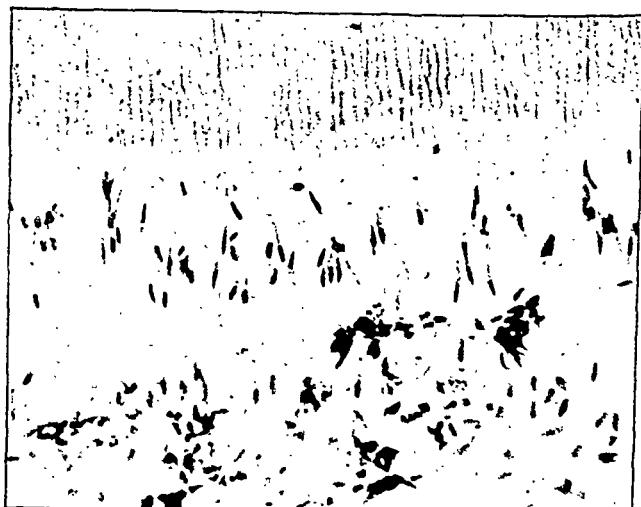


FIG. 2.  $\times 300$ .—Higher magnification of Fig. 1, under deepest part of cavity, showing scattered odontoblasts and their broken fibrils.

*Germicidal cement A.*—Fig. 4 shows that after twenty-four hours a severe reaction has occurred coinciding exactly in size and position with the extent of the lesion in the dentine. All the signs of acute inflammation are present. Degeneration and destruction of cells indicate the intensity of the irritant. All the odontoblasts under the affected tubules have perished. Inflammatory exudate forming large vacuoles (V) has collected at the site of irritation. At the extreme edge of the reaction (fig. 5) the normal odonto-

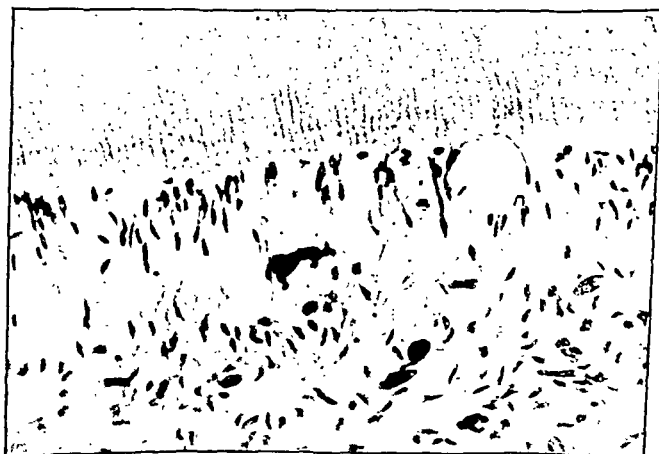


FIG. 3.  $\times 300$ .—Changes under control cavity filled with cotton wool soaked in olive oil.

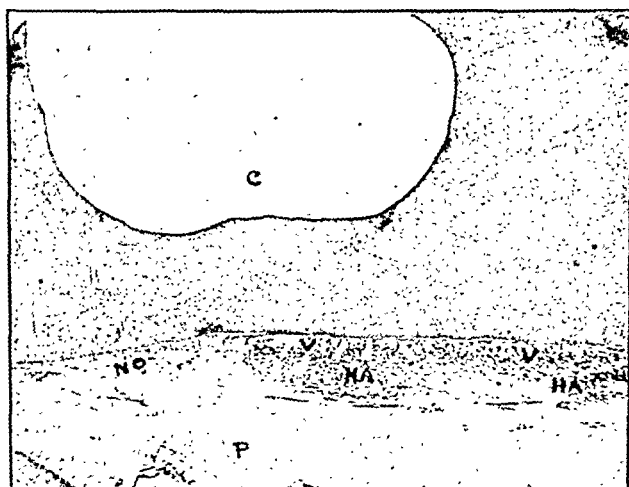


FIG. 4.  $\times 22$ .—Reaction under germicidal cement A. (24 hours). C.—Cavity. N.O.—Normal odontoblasts. V.—Vacuoles. H.A.—Hæmorrhagic area. P.—Normal pulp tissue.

blasts under the unaffected tubules are seen to be displaced laterally by the fluid exudate. Vascular changes are most marked (fig. 6). The walls of the dilated capillaries (C.) have given way and extensive hæmorrhages (H.A.) have occurred. Occasionally small hæmorrhages are seen in the non-irritated parts of the pulp, but this hæmorrhagic

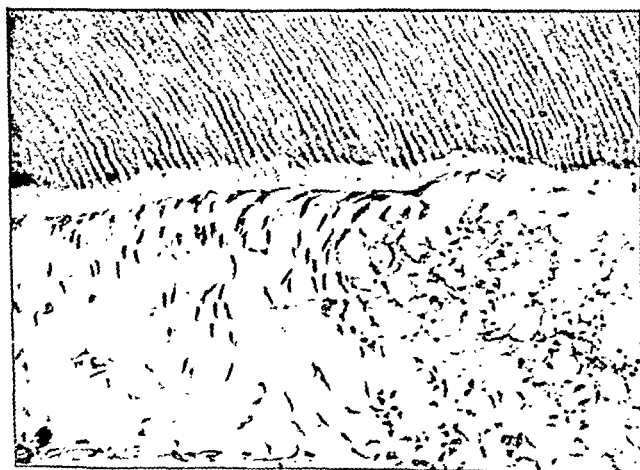


FIG. 5.  $\times 300$ .—Higher magnification of Fig. 4, at edge of reaction showing normal odontoblasts displaced laterally by fluid exudate.

area, coinciding in extent with the size and position of the cavity suggests strongly that it is due to congestion resulting from the opening up of a large number of tubules and the toxic effect of the filling material. In addition to the red cells, diapedesis of leucocytes has taken place and polymorphonuclear leucocytes are present in small numbers.

*Germicidal cement B.*—An acute inflammatory reaction has occurred (fig. 7), but destruction of the odontoblast cells is not so complete as in the previous case. The onto-

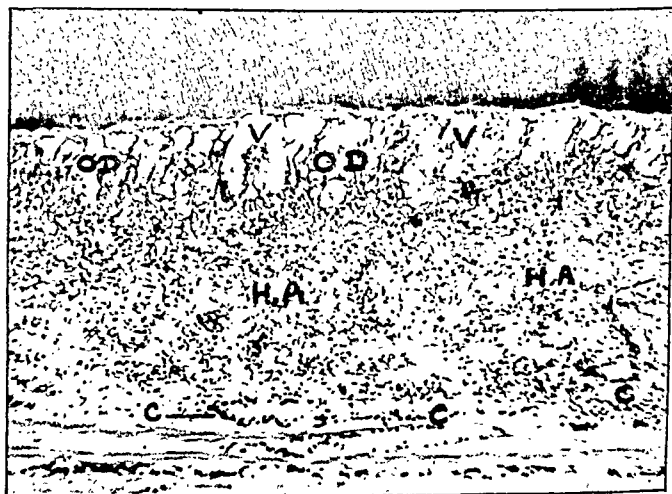


FIG. 6.  $\times 100$ .—Reaction under germicidal cement A.  
C.—Capillaries. H.A.—Hæmorrhages. O.D.—Odontoblast debris. V.—Vacuoles.



FIG. 7.  $\times 100$ .—Reaction under germicidal cement B.  
D.O.—Displaced odontoblasts. I.C.—Inflammatory cells. D.M.—Dentine margin. H.—Hæmorrhages.

blasts no longer attached to the dentine, are pushed away from it by the œdematous fluid. Inflammatory cells (I.C.) have found their way between the displaced odontoblasts (D.O.) and the dentine margin (D.M.) and polymorphonuclear leucocytes can be observed in the

fluid exudate close to the opening of the dentinal tubules (fig. 8). Extensive hæmorrhages (H.) have occurred in the pulp tissue under the odontoblast layer.

*Copper phosphate cements.*—These may be classed with germicidal cements. A severe reaction similar to that already described under a cavity filled with Germicidal Cement A of unknown composition is seen to have occurred. Fig. 9 shows normal odontoblasts (N.O.) and pulp tissue (P.) under the unaffected tubules (U.T.), together with the reaction

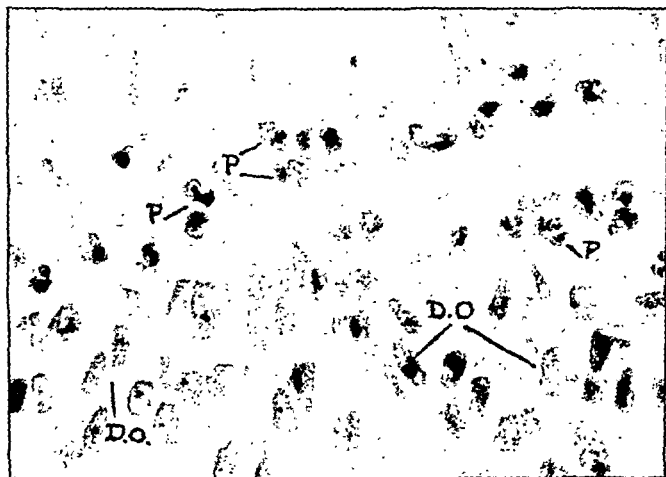


FIG. 8.  $\times 1250$ .—Higher magnification of Fig. 7, showing displaced odontoblasts (D.O.) and polymorphonuclear leucocytes (P.).



FIG. 9.  $\times 100$ . Reaction under copper phosphate cement (24 hours). N.O.—Normal odontoblasts. P.—Normal pulp tissue. U.T.—Unaffected tubules. C.T.—Tract of tubules under cavity. D.O.—Damaged odontoblasts. C.I.—Cellular infiltration of pulp.

under the tract of tubules connected with the cavity (C.T.). The contrast between the two areas is striking. The irritation has been intense and acute inflammatory changes are observed. Marked cellular infiltration of the pulp tissue under the damaged odontoblast layer has taken place, with the presence of polymorphonuclear leucocytes. The degenerated cell debris of the almost completely destroyed odontoblast layer under the



deepest part of the cavity is shown in fig. 10. Where the odontoblasts have undergone degeneration and show karyorrhexis is illustrated under high magnification in fig. 11.

*Zinc phosphate cements* (twenty-four hour reaction).—Although a marked reaction in the pulp tissue takes place under cavities filled with zinc phosphate cement, it is not so intense as that occurring under copper phosphate cement. The severe changes are confined more to the odontoblast layer, the pulp tissue underneath not being so seriously

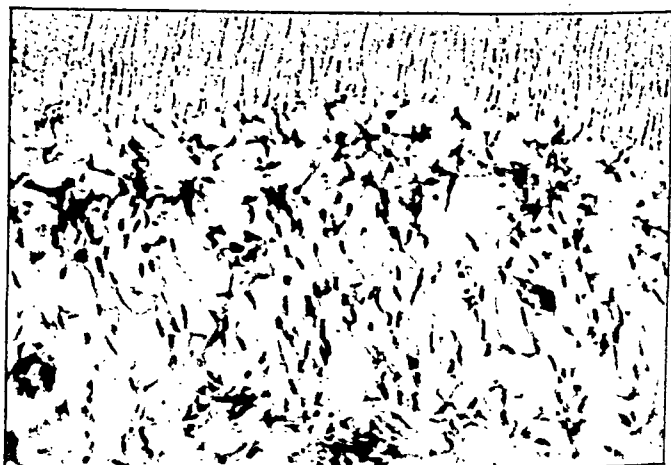


FIG. 10.  $\times 300$ . Reaction under copper phosphate cement. Higher magnification under deepest part of cavity.

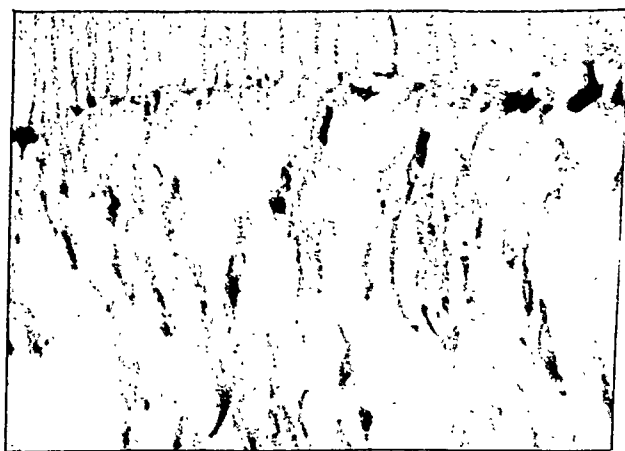


FIG. 11.  $\times 1250$ .—Degenerated odontoblasts showing karyorrhexis.

affected. Fig. 12 shows normal odontoblasts (N.) and the area of reaction (A) under the cavity. The damaged odontoblasts, having lost their fibrils, are seen to have been pushed away from the dentine surface by an accumulation of fluid exudate, which has formed definite oval spaces or vacuoles. Hæmorrhagic areas were observed in the pulp

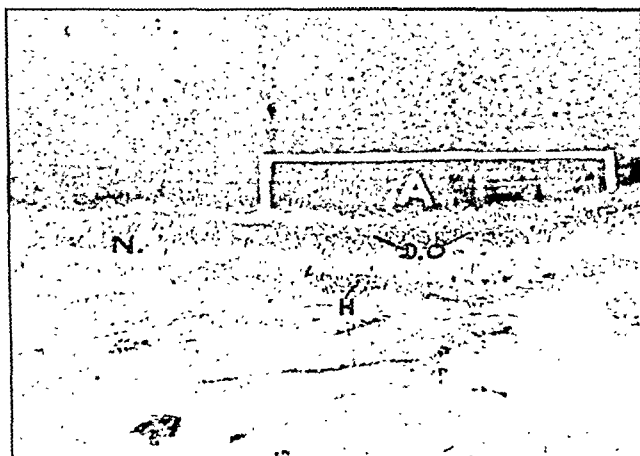


FIG. 12.  $\times 65$ .—Reaction under zinc phosphate cement (24 hours). N.—Normal odontoblasts. A.—Area of reaction under cavity. D.O.—Damaged odontoblasts pushed away from dentine surface. H.—Small hemorrhage.

tissue under the odontoblasts in a few sections of the series, but no general inflammatory disturbance of the pulp tissue corresponding in extent with the whole of the lesion in the dentine has taken place. Higher magnification of the reaction under the deepest part of the cavity is illustrated in fig. 13.

*Silicate cements.*—After twenty-four hours acute inflammatory manifestations are produced under cavities filled with silicate cements. Many cells of the odontoblast layer

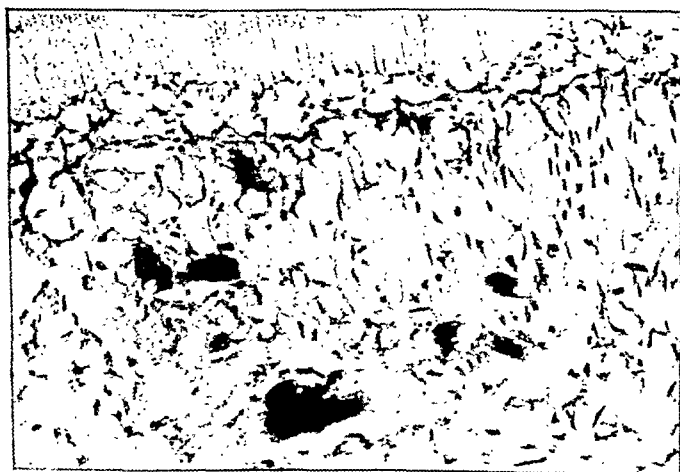


FIG. 13.  $\times 300$ . Higher magnification of Fig. 12 under deepest part of cavity.

have been destroyed while others have been pushed away from the dentine surface by the fluid exudate, which has formed vacuoles (V.) (fig. 14). Polymorphonuclear leucocytes (P.) in small numbers can be seen amongst the cell debris of the odontoblast layer between the displaced odontoblasts (D.O.) and the dentine surface, and can be seen actually emerging from the capillaries (figs. 15 and 16). Hæmorrhages, presumably due to congestion, have occurred deeper in the pulp tissue. For purposes of comparison



FIG. 14.  $\times 300$ .—Reaction under silicate cement (24 hours). I.C.—Inflammatory cells. V.—Vacuoles. D.O.—Damaged and displaced odontoblasts. C.—Capillary with escaped red cells.



FIG. 15.  $\times 1250$ .—Diapedesis. P.—Polymorphonuclear leucocytes emerging from capillary under odontoblast layer.

normal odontoblasts and pulp tissue under unaffected tubules above the lesion are shown in fig. 17.

*Zinc oxide and eugenol.*—For purposes of comparison with the acid cements changes were observed under a cavity filled with zinc oxide and eugenol for twenty-four hours. Even under a very deep cavity (fig. 18) the changes are confined to the odontoblast layer which has lost its close contact with the dentine margin by the breaking of the cell collars. The pulp tissue under the odontoblasts is normal, and no inflammatory changes

have taken place. Fig. 19 shows that the odontoblasts are shrunken and some, having lost their fibrils, show degenerative changes. Others have been drawn up close to the mouth of the tubules by contraction of the cut fibrils.

The histological picture exhibits certain points of similarity to that seen under the cavity of the experimental tooth used as a control, and the changes may, therefore, be in part due to the effect of the cutting of the fibrils by the bur. It is interesting to note that these changes are observed only in the sections under the deepest part of the cavity. Under all other cements tested the reaction is evident throughout the series.

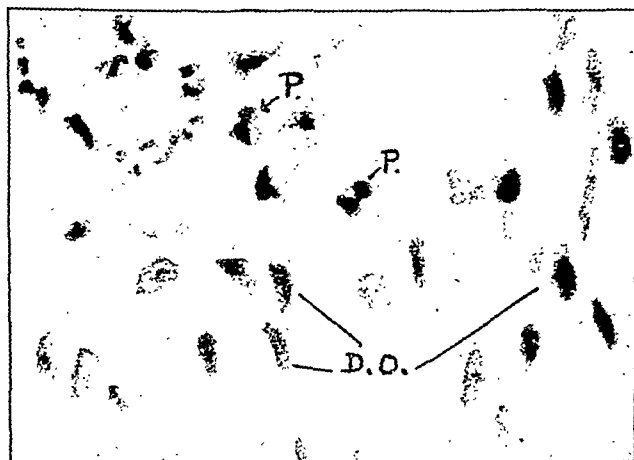


FIG. 16.  $\times 1250$ . D.O.—Displaced odontoblasts. P.—Polymorphonuclear leucocytes.



FIG. 17.  $\times 300$ . N.O.—Normal odontoblasts under unaffected tubules.

Although time does not permit a description of the later reaction of the pulp to these cements, it can be said that the formation of secondary dentine as an essential part of the process of repair is delayed until the clearing up process is completed. It is suggested that this may possibly be due to the chemical action of the filling material interfering with the matrix building enzymes (Fish, 1939). If the irritant causing degeneration and destruction is sufficiently weakened, it becomes a stimulant, and proliferation will result with the formation of secondary dentine. Ultimate recovery may take place in the manner described by Fish (1932), or, conversely, an abscess may form and the

whole pulp may eventually be destroyed. Except in those cases where the initial irritation is particularly intense, it is only in the latter contingency, as a result of complete death of the pulp, that clinical symptoms may become manifest. In one case only the initial irritation was sufficiently severe to cause intermittent pain within twenty-four hours.

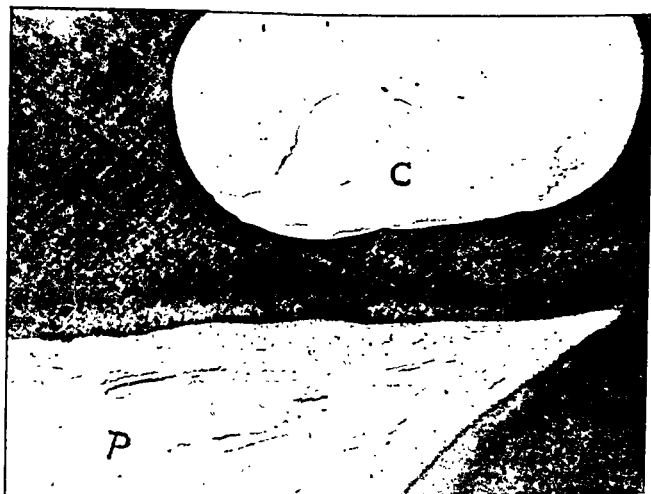


FIG. 18.  $\times 22$ .—Changes under zinc oxide—eugenol (24 hours). C.—Large and deep cavity. P.—Pulp tissue unaffected.

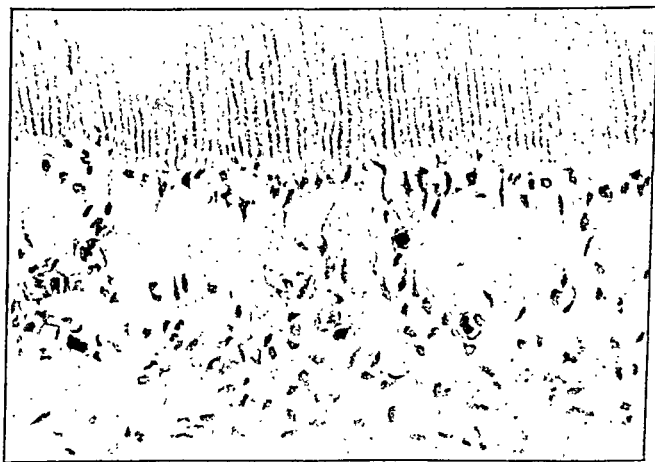


FIG. 19.  $\times 300$ .—Higher magnification of Fig. 18 under deepest part of cavity.

#### CONCLUSIONS

Where the liquid consists mainly of phosphoric acid dental cements are capable of producing severe localized reactions in the pulp within twenty-four hours. Reactions set up under zinc phosphate cements appear to be less intense than those resulting from either copper phosphate cements, silicate cements or certain cements purporting to have special germicidal properties. In the light of histological evidence it is clear that when using dental cements in their present form some modification of clinical procedure is indicated if the incidence of pulp involvement in any degree is to be prevented, especially in regard to the teeth of young subjects:

(a) Extension of the cavity involving the opening up of new and healthy tubules after removal of the carious dentine should be kept to a minimum.

(b) A thin smear of thickly mixed zinc oxide and eugenol used as a sublining is sufficient to prevent pulp irritation from acid cement.

While dental cements are designed to give certain desirable physical properties, it must be recognized that such properties should be dependent on the biological factors involved in their use. It seems to me, therefore, that it is of first importance in the manufacture of these materials that due consideration should be given to the histopathology and physiology of the dentine and pulp.

This work has been assisted by a grant from the Dental Board, to whom acknowledgments are due. The technical work of preparing the sections and photomicrographs has been carried out by my wife, to whom I am greatly indebted for her patience and skill.

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## The Distribution of the Enamel Cuticle and Its Significance

By ARTHUR I. DARLING, M.D.S.

#### INTRODUCTION

WHILE the organic matrix of the enamel has been carefully studied in its relation to dental caries (Williams, 1898; Malleson, 1925; Bödecker, 1927; Pincus, 1935), little attention has been paid to the organic structures on the enamel surface and their significance in this condition.

Nasmyth's membrane was first described in 1839 as an organic layer covering the enamel surfaces of unerupted and newly erupted teeth. Paul (1894) demonstrated its two component layers; an outer cellular layer and an inner hyaline layer which we now know as the enamel cuticle. Later investigators (Mummery, 1919; Gottlieb, 1921; Chase, 1926; *et al.*) traced the origin of these structures to the enamel organ. Williams (1923), Malleson (1924) and Fish (1928) established that the enamel cuticle was in continuity with the organic matrix of the enamel while Rosebury (1929, 1930) found that the chemical constitution of both structures was similar to that of the keratins.

While it is generally agreed that the enamel cuticle covers all the enamel surfaces of unerupted teeth, information as to its distribution on erupted teeth is scanty. Paul (1894) stated that it could be recovered from most erupted teeth; Chase (1926) and Dobbs (1932) found only small fragments of the cuticle on erupted teeth, while Kronfeld (1933) asserted that on similar teeth, large fragments could be demonstrated covering most enamel surfaces. The function of these fragments of the cuticle, according to Kronfeld, is to form an attachment between the gingival epithelium and the enamel. Paul (1895) and Gottlieb (1921) stated that the cuticle protects the enamel against caries, while Leigh (1926) asserted that it predisposes to caries. Organic membranes are easily recovered from the enamel surfaces of erupted teeth and have often been described. Dobbs (1932) stated that they were composed principally of mucin, but Gottlieb (1921) and Kronfeld (1933) found them to consist mainly of fragments of the enamel cuticle.

#### INVESTIGATIONS

In the present investigation membranes were recovered from the enamel surfaces of a number of erupted teeth.

The teeth were scaled, scrubbed till free of stainable debris and then immersed in 10 to 20% nitric acid to which 1% of phloroglucin had been added. As the membranes floated free they were teased off, washed and mounted on slides for staining with hæmatoxylin and eosin and subsequent examination. Two hundred specimens were examined by this method. These were recovered from incisors, canines, premolars and molars from patients of 8 to 60 years of age.

Their histological, chemical and physical characteristics were identical with those of the enamel cuticle. By means of celloidin sections their attachments to both the organic matrix of the enamel (fig. 3) and to enamel lamellæ were demonstrated.

The methods available for the demonstration of the enamel cuticle *in situ* were either the partial decalcification of ground sections (Underwood and Wellings, 1914), celloidin impregnation (Mallison, 1924, 1925), or the acid celloidin technique (Bödecker, 1927). In sections prepared by these methods, however, displacement or distortion of the cuticle prevented an accurate determination of its distribution. For this reason a new technique

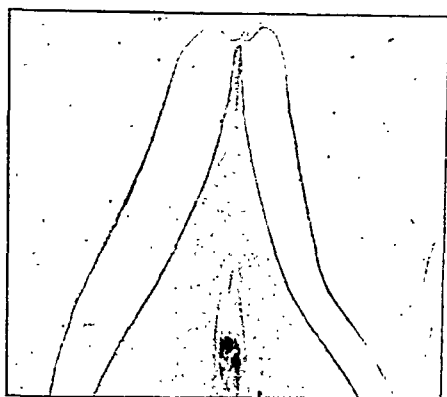


FIG. 1.—Decalcified ground section of a lower canine showing the enamel cuticle *in situ*. It has been lost from the incisal margin by attrition. Patient aged 24 years.

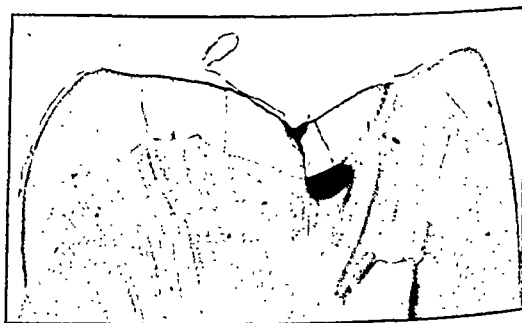


FIG. 2.—Ground section of an upper molar from a patient aged 68 years. It was partially decalcified to show the enamel cuticle *in situ*. The cuticle has been lost from the buccal cusp and buccal surface by attrition.

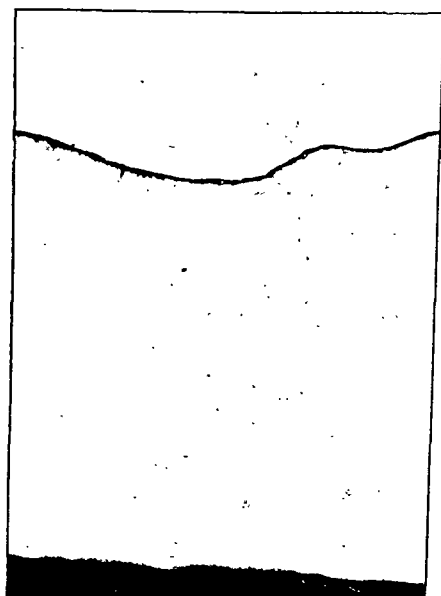


FIG. 3.—Decalcified section of an erupted premolar showing the enamel cuticle with fragments of the organic matrix of the enamel attached.

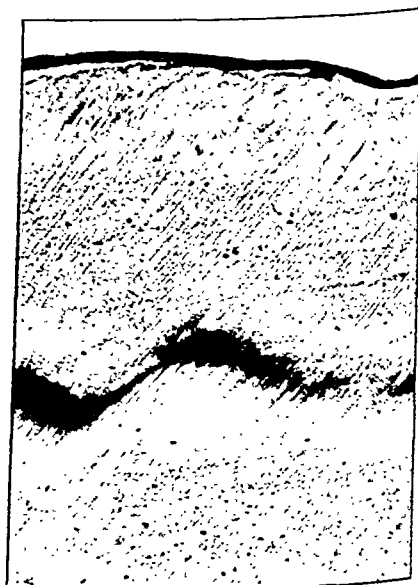


FIG. 4.—Ground section of enamel showing early artificial caries with underlying translucent zone.

was evolved. In this, ground sections were completely decalcified and the cuticle was retained *in situ* with gelatin.

The teeth were cleaned by scrubbing and immersion in 25% sodium hydroxide. Sections 5-10  $\mu$  in thickness were ground and attached to slides coated with egg albumin by means of 10% gelatin. After drying the gelatin was hardened with 20% formaldehyde. The sections were then decalcified in 2% hydrochloric acid and the enamel cuticle adhered to the gelatin. The sections were washed and soaked again in 20% formalin for ten minutes.

After further washing they were stained with hæmatoxylin and eosin and decolorized till the gelatin was clear. The sections were then mounted in glycerol jelly (gelatin 10%) and ringed with shellac varnish.

Two hundred and ninety teeth were examined by this method. They included incisors, canines, premolars and molars from patients of 8 to 68 years of age.

By this method the distribution of the enamel cuticle and its attachment to enamel lamellæ could be demonstrated. The cuticle was demonstrated on all teeth regardless of age. It covered all the enamel surfaces of newly erupted teeth but older teeth showed its absence from the incisal margins of incisors and canines and the occlusal surfaces of the cusps of premolars and molars (figs. 1 and 2). Even the oldest teeth, which were from a patient of 68 years of age, showed large fragments of the cuticle covering the lateral enamel surfaces and lining occlusal pits and fissures (fig. 2). The cuticle was lost also from those enamel surfaces previously abraded with fine sandpaper discs. The enamel cuticle, therefore, is present on all enamel surfaces not subject to natural or artificial attrition or abrasion.

The correlation of these findings with the results of concurrent investigations into the distribution of so-called carious lesions produced *in vitro* is significant.

For the production of "carious" lesions *in vitro* the recognized methods of Miller (1890), McIntosh, James and Lazarus-Barlow (1922) and Clarke (1924) were employed.

The teeth were cleaned, autoclaved and immersed in tubes of media. The media used were (a) sterile bread and saliva, (b) sterile 1% lactose broth. These were inoculated with one of the following: (1) *Bacillus acidophilus odontolyticus* I; (2) *Bacillus acidophilus odontolyticus* II; (3) *Streptococcus mutans*; (4) Mixed mouth organisms. All were incubated at 37° C. and the media and inocula were renewed three times each week. The duration of each experiment was from eighteen to twenty-four weeks. Sixty teeth were treated by this method. There were incisors, canines and premolars from patients of various ages. Seven teeth showed no lesion. Of these four were controls and three were newly erupted teeth removed for orthodontic reasons.

Lesions were produced in fifty-three erupted teeth of various ages and their incidence showed relationship neither to the type of medium, nor to the inoculum. The lesions closely resembled those of natural caries in both macroscopic and histological appearances. In the enamel surrounding a number of these lesions translucent zones were demonstrated (fig. 4) which were identical with those occurring in natural caries described by Mummery (1926). The lesions were invariably situated at the incisal margins of incisors and canines and on the occlusal surfaces of the cusps of premolars and molars but could be produced in any enamel surface by gentle abrasion with sandpaper discs prior to incubation in the "caries"-producing medium. Cleansing of the teeth by boiling in 25% sodium hydroxide for one hour caused no variation in the distribution of the lesions. Histologically most enamel surfaces showed slight changes similar to the precarious decalcification described by Bunting and Hill (1940). These changes involved only the superficial layers of unabraded enamel and never progressed to cavity formation but over cusps and incisal margins penetration was greatly increased and the dentine was frequently involved. The maximum acidity of the media was pH 3.5 and identical lesions of similar distribution were produced by the incubation of similar teeth in dilutions of lactic acid less than 0.075% (pH 3.5) as shown by Mummery (1909) and Dobbs (1932).

#### DISCUSSION

From these investigations it is apparent that the production of caries *in vitro* is not dependent on any specific organism but rather on the acid produced by the acidogenic organisms when cultured in a carbohydrate medium. The presence of translucent zones in the enamel surrounding "carious" lesions produced *in vitro* shows that these zones may occur independently of any vital reaction. This is contrary to the view held by Mummery (1926) who stated that they were a vital response to caries. The distribution of the lesions indicates that the enamel of erupted teeth has a cortical protection against artificial caries and dilute acids of less acidity than pH 3.5. This protection is present over all enamel surfaces except those subject to natural or artificial attrition or abrasion. The cause of this protection has not yet been conclusively demonstrated. Box (1942) states that the tooth surface is protected by an organic deposit and Gore (1942) has shown that precipitated mucin is impermeable to dilute acids, but it is unlikely that any surface deposit would persist after boiling in 25% sodium hydroxide. In attrition or abrasion of the enamel surface the enamel cuticle is removed and it is probable that the hypercalcified cortical layer of enamel described by Karlstrom (1939) and Thewlis (1934) is injured. The difference in degree of calcification between normal enamel and the hypercalcified zone is so small that it seems unlikely that it could cause such a marked variation in their resistance to prolonged acid attack. The enamel cuticle is insoluble in either acids or alkalis and its distribution is identical with that of the cortical enamel



protection. This strongly suggests that a relationship exists and although conclusive evidence is as yet lacking, it is most probable that the enamel cuticle protects the enamel surface against attacks by dilute acids such as occur in the production of caries *in vitro*. The significance of such a protection against natural caries is evident, but the analogy between caries *in vitro* and *in vivo* cannot be carried too far. If the validity of this comparison be accepted, as it has been in the past (Miller, 1890; McIntosh, James and Lazarus-Barlow, 1922; and Clarke, 1924), then a new factor in the ætiology of caries has been demonstrated.

## SUMMARY

- (1) The enamel cuticle is present on the enamel surfaces of all erupted teeth. It is absent only from those areas subject to natural or artificial attrition or abrasion.
- (2) Carious lesions produced *in vitro* are the direct results of acid attack and are not related to any specific organism.
- (3) Translucent zones in the enamel surrounding carious lesions may occur independently of vital reaction.
- (4) The enamel of erupted teeth has a cortical protection against attack by dilute acids. Protection is lost from those areas subjected to natural or artificial abrasion. It appears most probable that the enamel cuticle is responsible for this protection. It is effective against "caries" produced *in vitro* and may play some part in the prevention of natural caries.

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# Section of Epidemiology and State Medicine

President—E. H. R. HARRIES, M.D.

[May 28, 1943]

## The Scottish Diphtheria Immunization Campaign (1941 to 1942)

By Sir ALEXANDER RUSSELL, C.B.E.

*Diphtheria death-rates, 1855 to 1943.*—Graph 1 depicts the diphtheria death-rates in Scotland per 100,000 of the population from 1855 to 1943. It will be noted that the enormous death-rates recorded during 1862 to 1865 entirely dwarf all later figures. Again, during the long period between 1873 and 1933, the general trend in the death-rate has been continuously downward. Since 1933, the rate has remained more or less stationary except for the 1940 epidemic wave and the later fall in 1942. A large decrease in the death-rate occurred between 1894 and 1897, a period following shortly after the passing of the Infectious Diseases Notification Act (1889) which made diphtheria and membranous croup *optionally* notifiable. It was the Public Health (Scotland) Act, 1897, which extended to the whole of Scotland *compulsory* notification of these diseases. Lastly, it is worth comparing the small wave caused by the 1940 to 1941 epidemic with the terrible waves experienced during the second half of last century.

*Recent events.*—Following three years of comparative quiet, a period of increased incidence began, in parts of Scotland at least, in 1934. This culminated during 1940 in a somewhat severe epidemic which continued on a lesser scale during the winter of 1941 to 1942. Table I gives notifications by quarters for the twelve years 1931 to 1942; Graph 2 perhaps gives a more striking picture of the high seasonal peaks which occurred during the winter months of 1940 to 1941 and of 1941 to 1942.

TABLE I.—NOTIFICATIONS OF DIPHTHERIA IN SCOTLAND, 1931 TO 1943.

Quarter	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943
1st	2,559	2,577	1,939	3,403	3,685	2,828	2,788	3,339	2,657	2,715	4,471	2,883	2,787
2nd	2,066	1,845	1,709	2,748	2,356	2,139	2,320	2,360	3,030	3,030	2,635	2,298	2,214
3rd	1,964	1,550	1,967	2,551	2,073	1,846	2,086	1,860	2,109	3,396	2,642	2,295	
4th	2,467	1,993	3,228	3,573	2,931	3,435	3,202	3,218	2,900	3,070	3,388	3,138	
Total	9,376	7,965	8,843	12,275	11,065	10,268	10,396	10,786	9,942	15,711	13,586	10,614	

For total to five years before 1940, a few local authorities in Scotland had made some attempt to immunize their child populations. Although the numbers inoculated were small in relation to the child population as a whole, in some areas the results obtained seemed to show that the "one-shot" method, followed by a post-Schick test and reinoculation of those still Schick-positive, conferred a considerable degree of protection against diphtheria. For instance, in Aberdeen County where this method was practised from 1935 to 1940, the diphtheria incidence in 1940 was only one-fifth of that in 1935, whilst of the 81 children who died of diphtheria during these six years only one was immunized. Moreover, the death-rate from diphtheria in 1940 was only one-fifth of that recorded in 1935. In addition to these localized efforts, some medical officers of health had noted the rising incidence in early 1940 and, prior to the initiation of the national immunization campaign in November, had begun to inoculate the children in their areas. It has been estimated that those immunized up to the end of 1940 numbered about 122,000.

At the end of 1940, therefore, except for a small percentage, Scottish children were unprotected against diphtheria and the country was experiencing a widespread epidemic. Diphtheria in this country shows a definite seasonal wave, the peak incidence occurring in late December or early January and the minimum in July and August. As immunity is not usefully established until three or four months after inoculation with toxoid, immunization of the children should as far as possible be carried out during the late summer or early autumn months. Alike from the experimental as from the immunological point of view, therefore, the national immunization campaign should have opened much earlier in the year. But those of us who have spent any time in attempting to control epidemic disease realize only too well how difficult it is to obtain public interest in, and support for, a preventive campaign until an outbreak has actually become a menace to the community. And so, as usual, this immunization effort began only when the epidemic was approaching its peak.

*Toxoids.*—It was decided to supply all local authorities with free issues of diphtheria toxoids, those available being A.P.T. and T.A.F. Medical officers of health were urged

to refrain from ordering at any one time more than they could use within a period of two to three weeks. In respect of A.P.T., the Department of Health advised doses of 0.2 and 0.5 c.c. with an interval of not less than four weeks between the two doses, the injections to be given intramuscularly in alternate arms.

During the early stages of the campaign, 25 c.c. phials of toxoid were found very suitable because of the large numbers attending the inoculation clinics. This was fortunate, as for some weeks the smaller 1 c.c. and 5 c.c. phials were difficult to obtain. At the same time insistent demands by private patients compelled the issue to practitioners of large phials when the smaller varieties would have sufficed, so that some wastage of material was incurred during the early weeks of 1941. However, as time went on, general practitioners and other doctors were able to get toxoid in quantities suited to their needs.

*Reactions.*—Literature on the subject indicates that for children over 8 or 9 years of age, T.A.F. is the toxoid of choice, because with A.P.T., in the older age-groups, local reactions are more apt to occur. This differentiation was adopted by one or two Medical Officers of Health, but generally speaking A.P.T. has been used for all age-groups and our experience would seem to indicate that even in older children it causes few untoward reactions. In a small percentage, some local swelling and redness occurred but, usually, these signs were not evident more frequently among the older children than in the younger age-groups. Only in one instance was the reaction such that the family doctor (who did not give the inoculation) felt impelled to notify it—incorrectly—as a case of acute erysipelas!

In one area, where the inoculations were given by two junior assistants, some 18 abscesses occurred within a period of fourteen days. These were obviously due to errors in technique since, when the work was undertaken by others, no further trouble was experienced.

None of the 800,000 inoculated children (with the exception of those already mentioned) suffered from local or febrile reactions which gave any cause for anxiety to parents or doctors.

*Numbers immunized.*—The following table contains an estimate of the numbers of children inoculated up to the end of 1940 and figures for the four half-years of 1941 and 1942:

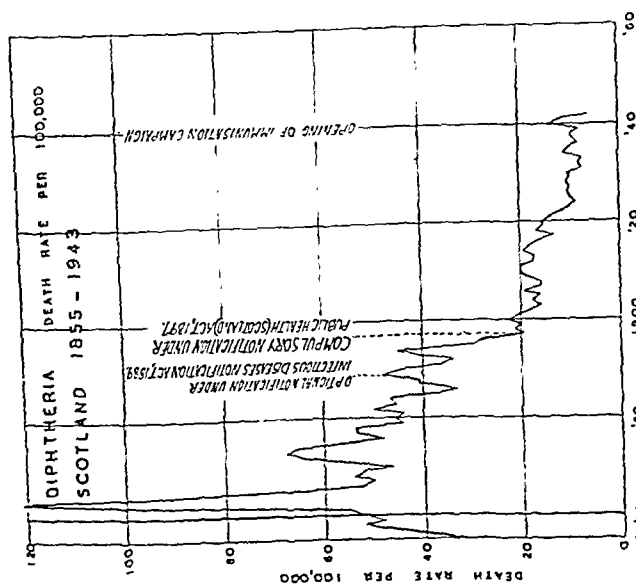
TABLE II.—NUMBERS IMMUNIZED.

Prior to 1941	...	...	...	Pre-school 22,489	School 99,847	Total 122,336
1941	{	1st half	...	105,285	385,576	490,861
		2nd half	...	48,628	79,216	127,844
1942	{	1st half	...	37,776	59,250	97,026
		2nd half	...	19,914	12,642	32,556
Total				211,603	536,684	748,287

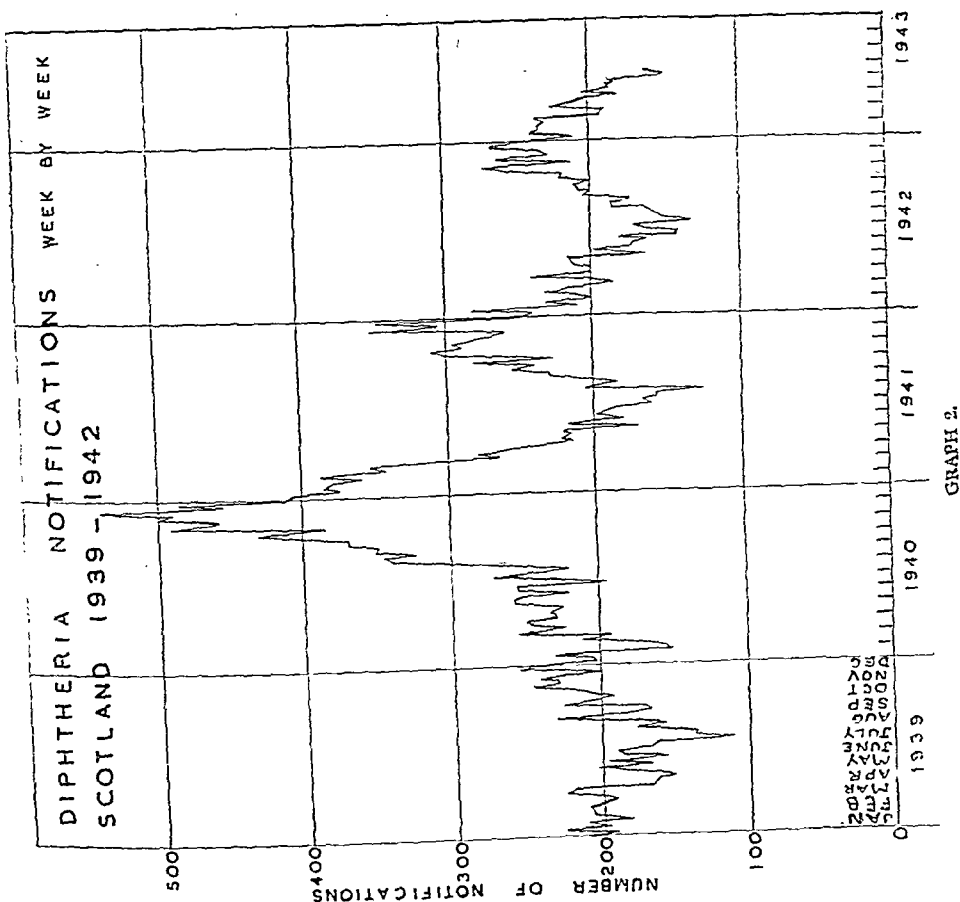
The table gives a good idea of the way in which the campaign proceeded. The figures include a much higher proportion of school than of pre-school children and by far the largest numbers were done in the first of the four half-years. Propaganda—national and local—during the opening phases of the campaign was for a time almost embarrassingly effective. Various publicity methods were adopted but experience in Scotland coincided with that south of the border. Every broadcast on the subject was followed by an increased though somewhat evanescent demand, but schools and child welfare clinics were the most effective centres for spreading information. School teachers everywhere played a willing and valuable part, not only in persuading parents to give consent but in organizing immunization clinics in the schools. Mothers were encouraged to bring their infants to the school clinics and considerable numbers were inoculated in this way. In many areas, health visitors also did fine propaganda work during their home visits. Some medical officers of health had all the inoculations done by their own staffs; others opened special clinics where medical practitioners did the work on a sessional fee basis. Mobile vans and inoculation teams have been only moderately successful and, on the whole, this plan of campaign was found to be costly both in time and in medical man-power. The same criticism applies to the carrying out of inoculations in individual houses by members of public health staffs. All private practitioners were given free supplies of toxoid, whilst a few local authorities paid for every child inoculated.

As a result of these combined efforts, in a number of areas 80%, 90% and even 95% of the school children and 60 to 75% of the pre-school children were inoculated. The response, generally speaking, was considerably greater in rural than in urban areas, but everywhere the pre-school age-group presented, and still presents, a difficult problem.

It is commonly stated that 85% of the child population should be immunized to ensure successful results. Towards the end of 1941 it is estimated that approximately 71% of the school children and 56% of the pre-school children in Scotland had been inoculated, so



GRAPH 1.—From graph prepared by Dr. J. Ritchie, M.O.H., Dumfries County.



GRAPH 2.

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Total			211,603	536,684	748,287

The table gives a good idea of the way in which the campaign proceeded. The figures include a much higher proportion of school than of pre-school children and by far the largest numbers were done in the first of the four half-years. Propaganda—national and local—during the opening phases of the campaign was for a time almost embarrassingly effective. Various publicity methods were adopted but experience in Scotland coincided with that south of the border. Every broadcast on the subject was followed by an increased though somewhat evanescent demand, but schools and child welfare clinics were the most effective centres for spreading information. School teachers everywhere played a willing and valuable part, not only in persuading parents to give consent but in organizing immunization clinics in the schools. Mothers were encouraged to bring their infants to the school clinics and considerable numbers were inoculated in this way. In many areas, health visitors also did fine propaganda work during their home visits. Some medical officers of health had all the inoculations done by their own staffs; others opened special clinics where medical practitioners did the work on a sessional fee basis. Mobile vans and inoculation teams have been only moderately successful and, on the whole, this plan of campaign was found to be costly both in time and in medical man-power. The same criticism applies to the carrying out of inoculations in individual houses by members of public health staffs. All private practitioners were given free supplies of toxoid, whilst a few local authorities paid for every child inoculated.

As a result of these combined efforts, in a number of areas 80%, 90% and even 95% of the school children and 60 to 75% of the pre-school children were inoculated. The response, generally speaking, was considerably greater in rural than in urban areas, but everywhere the pre-school age-group presented, and still presents, a difficult problem.

It is commonly stated that 85% of the child population should be immunized to ensure successful results. Towards the end of 1941 it is estimated that approximately 71% of the school children and 56% of the pre-school children in Scotland had been inoculated, so

inoculated more than three months before they were tested. Table IV contains figures for Kilmarnock which Dr. Nisbet, Medical Officer of Health, has kindly allowed me to quote.

Now that medical officers of health have brought into force their permanent immunization schemes, under which "one year olds" are to be given two inoculations and all school entrants will receive a "boosting" dose of 0.5 c.c., they have been advised to carry out a post-Schick test on as many as possible of the inoculated children. This method has been advised not only for the purpose of detecting those who have not responded to the toxoid but also to ascertain whether or not the "boosting" dose at school entrance is sufficient to carry the child safely through its school life.

**Carriers.**—Professor Tulloch has found no evidence from the examination of swabs from 796 children that an abnormal carrier rate exists among the immunized. His figures are seven positives in 369 immunized children and nine positives in 426 non-immunized.

**Variations in type of *B. diphtheriæ*.**—Variations in the prevalent type of *B. diphtheriæ* have been recorded within more recent years in different parts of Great Britain, Canada and America. The Monthly Bulletin of the Emergency Public Health Laboratory Service for April, 1943, contains a summary of the latest information on this subject. Apparently different parts of England have had different experiences; some have had a high "gravis" and a low "intermedius" and "mitis" percentage; in others, this position has been reversed.

Figures for Edinburgh recorded by Wright (1940) show that, during 1936, gravis infections amounted to less than 10%, whilst in 1939 they were 60 to 70% and the intermedius percentage had fallen correspondingly. In his 1941 Report, Sir Alexander Macgregor, Medical Officer of Health for Glasgow, says that "the rise in the frequency of occurrence of *B. diphtheriæ gravis* was maintained. Of 1,491 strains examined during the year, 60% were gravis compared with 58.6% last year. The relative percentages of *B. diphtheriæ intermedius* and *B. diphtheriæ mitis* were both a little lower than last year.

Other Medical Officers of Health have observed that during 1941 and 1942 the gravis type was met much more frequently than before. During 1942 it became clear that this change in type had occurred over a considerable part of the country.

In no area has the change been more marked than in the city of Dundee. Professor Tulloch, who carries out all bacteriological examinations for the health department of the city, has kindly given me permission to quote some of his figures and conclusions. During 1933 to 1934, it was found that of 427 positive cases of diphtheria, 19 were *B. diphtheriæ gravis*, 256 were infected with various intermediates and 152 with *B. diphtheriæ mitis*. Between 1935 and 1939 the only diphtheria cultures examined in detail were from convalescents in whom infection persisted after clinical care. Of the 213 examined, 1 was gravis, 133 were intermedius and 79 were mitis.

The next figures cover 1940 and these are peculiarly interesting. Between January 1, 1940, and June 30, 1940, 10 cases were examined, 9 being intermedius and 1 mitis. Between July 1, 1940, and September 30, 1940, of 18 cases examined, 3 were gravis, 13 were intermedius and 2 mitis. From October 1, 1940, to December 31, 1940, of 19 cases, 14 were gravis, 4 intermedius and 1 mitis. It would seem, therefore, that the gravis type became prevalent in the district of Dundee for the first time in the autumn of 1940, that the change in type was not one of "gradualness" and that, as recent records prove, the new type has remained strikingly predominant. For instance, no less than 921 out of 1,021 strains isolated in the East Central area of Scotland during the period October 1941 to October 1942 belonged to a single serological type of *B. diphtheriæ gravis*, viz. Type I gravis as defined by Robinson and Peeney. Of the remaining 100 strains, 74 were intermediates and 26 mitis. Table V summarizes the changed position.

TABLE V.—PREVALENCE OF TYPES OF *B. DIPHTHERIÆ* IN DUNDEE.

	Gravis	Intermedius	Mitis
1933 to 1934 ... ..	6%	56%	38%
1941 to 1942 ... ..	87%	10%	3%

In Professor Tulloch's opinion, the fact that the gravis type has replaced the other types which for a long period had been endemic to the population means that to-day, in a large part of Scotland, diphtheria is a different malady. At the same time, it is to be noted that in the Dundee area the predominating gravis organism, which has been responsible for a marked increase in the incidence of this disease among the non-immunized during the epidemic of 1940 to 1942, has not been particularly lethal.

**Changes in age-group incidence.**—In regard to age-incidence, Professor Tulloch made a further analysis of cases coming under his bacteriological scrutiny and found that when he compared the 1941 to 1942 figures for each age-group with those for 1933 to 1934, there had occurred a remarkable drift of incidence to the "over 15 years" age-group, a drift so marked that it is most improbable it can be due to mere chance.

that our maximum effort fell considerably short of the target. At the same time, the figures quoted represent a vast amount of labour; the work involved a heavy addition to the serious wartime burden already being borne by Medical Officers of Health and general practitioners alike.

During the second half of 1942, as the figures indicate, there was a serious falling-away from the earlier enthusiastic response and it is probable that at the moment only about 60% of the child population is protected. It is to be hoped that this figure will not decrease further, otherwise Scotland may, sooner rather than later, find herself back to the unsatisfactory position which existed three years ago.

**Poliomyelitis.**—Eight children, living in three different areas of Scotland, developed somewhat similar symptoms some time after inoculation with A.P.T. In the first group of three, both injections had been given in the same arm and paralysis of certain arm and shoulder muscles occurred on that side. The condition in each case was diagnosed by a specialist in children's diseases as acute poliomyelitis, no relationship with the inoculations being thought of until it was later ascertained that all three had been inoculated (along with 4,000 others) with the same batch of toxoid. Some months later, a further five cases were reported at intervals—three in one area and two in another; these were diagnosed as brachial neuritis, a condition which is said occasionally to accompany serum sickness. In all eight children, varying degrees of paralysis were associated with the 5th and 6th cervical nerves and appeared from fourteen to twenty-five days after the second injection. Immediate steps were taken to test samples of the batch of toxoid used in the first three cases. These passed standard sterility and toxicity tests and no evidence was obtained of the presence of a neurotropic virus in the samples, although it should be added that shortage of experimental monkeys prevented as full an investigation as otherwise might have been conducted. It is not possible here to give complete clinical details; it can be stated, however, that six of the eight cases have made a complete or almost complete recovery. The other two are still under treatment and one has been diagnosed as anterior poliomyelitis. As several thousands in all were inoculated with the same batches of toxoids as these three groups of children, it seems doubtful that the A.P.T.s were contaminated with a poliomyelitis virus. Were these manifestations (if they were a sequel to inoculation) allergic in character or were other factors such as nerve-trauma, malnutrition, or avitaminosis involved? It may not be possible to reach a definite conclusion, but it will be readily appreciated that the association, in time, of such symptoms with A.P.T. inoculations was not only disturbing to all concerned but might have given a serious setback to the national immunization campaign.

**Post-Schick tests.**—It will be realized that during a national campaign, when large numbers of children were being inoculated every week, there was neither time nor opportunity for the carrying out of post-Schick tests. Lewis (1941) holds that such tests are unnecessary when a potent A.P.T. is in use but, even if other opinions had prevailed, it was frankly a physical impossibility to make any systematic post-Schick examination of the many thousands of children immunized during these past two years. By this omission, no doubt, there was left undetected a small percentage of children whose immunity failed to develop and who for that reason were still liable to attack, but in existing circumstances that risk had to be taken. The small number of diphtheria deaths among "immunized" children would appear to indicate that, in respect of mortality at least, the risk was slight and that, during the period under review, the advantages to be derived from testing every inoculated child in the country would have been incommensurate with the extra time and labour involved.

It is not to be understood, however, that no post-Schick tests were carried out in Scotland. In several areas, considerable numbers of tests were made and I am indebted to Dr. Burgess, Medical Officer of Health, Dundee, for permission to give some details of 5,709 children tested during 1941. In this group A.P.T. was, generally speaking, used to inoculate children up to the age of 10 years and T.A.F. for persons over that age. The tests were made only *two months* after the last injection. This rather short period was deliberately selected because, if it had been prolonged, many of the children would never have been brought back for inspection. As it was, absentees numbered 362.

TABLE III.—POST-SCHICK TESTS IN DUNDEE.

	0 to 5 years	5 to 10 years	10 + years
Number performed	1,761	2,719	1,229
Negative	1,562 (94.8%)	2,346 (90.4%)	1,027 (83%)
Positive	84 (5.2%)	250 (9.6%)	76 (7%)
Absentees	115	123	124

TABLE IV.—AND IN KILMARNOCK.

	0 to 5 years	5 to 10 years	10 + years
Number performed	2,304	3,535	627
Negative	2,222 (98.2%)	3,412 (97.2%)	597 (96.9%)
Positive	40 (1.8%)	98 (2.8%)	19 (3.1%)
Absentees	42	25	11

The "negative" percentages are somewhat lower than those quoted by Lewis but it is probable that, in a considerable number, immunity had not fully developed at the time the tests were carried out. This is confirmed by the higher percentages of Schick negatives recorded by other Medical Officers of Health among children who had been

There can be no question of the severity of the 1940 to 1941 diphtheria epidemic. The second and third quarters of 1940 gave abundant warning of impending events and the fourth quarter's total of 233 deaths was much the highest of any quarter in the twelve years under review. A heavy mortality continued during the first quarter of 1941 but by the spring of that year the worst was over.

The immunization campaign, begun only in mid-December 1940, could not be expected to have any significant effect either on incidence or on mortality during the first half of 1941. Indeed, mortality figures for the last two quarters of 1941 and for the first quarter of 1942 are all of much the same order as those for the corresponding quarters of pre-epidemic years, so that up to March, 1942, it cannot be said that there had been any remarkable decrease in diphtheria mortality. On the other hand, the deaths recorded during the second, third and fourth quarters of 1942 show striking reductions and are all much below any figures previously recorded in Scotland. The mortality figure for the first quarter of 1943 is 75, which shows that the large reduction continues. The total of 250 deaths for the twelve months from April 1, 1942, to March 31, 1943, is still more remarkable and gives some cause for restrained optimism.

The question may be asked whether the low mortality figures during the last four quarters are merely those of a period of post-epidemic quiescence or whether they prove the efficacy of immunization. One point in favour of the latter alternative is that in no previous post-epidemic period have the numbers of deaths fallen to such a marked extent. The fact that the decrease has extended over a complete twelve-months' period also tends to support that explanation, although native caution forbids my giving a more definitely optimistic opinion until further statistics become available.

In the next table are shown the total deaths from diphtheria, divided into age-groups, for the period 1931 to 1939 and for 1940, 1941 and 1942, with the percentage each group bears to the total for the twelve months.

TABLE IX.—TOTAL DEATHS FROM DIPHTHERIA AT SEVERAL AGE-GROUPS DURING 1931 TO 1939, 1940, 1941 AND 1942 AND THE PERCENTAGE OF THE TOTAL IN EACH AGE-GROUP.

Ages	1931-1939			1940			1941			1942		
	Deaths	% of total		Deaths	% of total		Deaths	% of total		Deaths	% of total	
0 to 5 years ...	1,782	46.72		352	52.15		281	54.35		157	54.1	
5 to 15 years ...	1,788	46.88		280	41.48		185	35.78		96	33.1	
15 and upwards ...	244	6.40		43	6.37		51	9.87		37	12.8	
Total	3,814											
		9	= 424	675			517			290		

The first point to be noted is that, whilst the percentage of deaths for 1940 in the "over 15 years" group varied little from the average, in 1941 and 1942 the figure for this group rose rapidly and in the latter year was double the pre-epidemic average. Both incidence and mortality in this age-group, therefore, have risen to a significant extent during the past two years, not only in the Dundee area, but in the country as a whole.

As regards mortality in the "0 to 5 years" age-group, the percentage in 1940 showed a considerable increase as compared with the pre-epidemic average and during 1941 and 1942 the rates were still higher.

In the "5 to 15 years" age-group, there has been a progressive fall—similar to that which occurred in notifications—in the percentage of deaths during the years 1940, 1941 and 1942. The decrease in 1940 cannot be attributed to immunization. The continued fall in numbers and percentages during 1941 and 1942 may be related to the large proportion of the school child population immunized during these two years.

*Case mortality rates.*—Another interesting range of figures consists of percentage case-mortality rates for diphtheria in Scotland from 1900 onwards. Space forbids the presentation of rates for each of the forty-two years but the following table includes a number sufficient to demonstrate the striking reduction which has taken place since the beginning of the century.

PERCENTAGE MORTALITY RATES.

TABLE X

1900	= 19.0	1926	= 6.1
1901	= 17.9	1931	= 4.0
1902	= 15.6	1934	= 4.0
1903	= 13.7	1936	= 4.0
1905	= 13.7	1939	= 4.2
1911	= 9.5	1940	= 4.5
1913	= 8.1	1941	= 4.1
1920	= 6.7	1942	= 2.75
		(1st half = 3.3%)	
		(2nd half = 2.2%)	

TABLE XI

	2nd quarter	3rd quarter	4th quarter	1st quarter	Total
1937 to 1938...	4.01	3.79	3.94	4.22	4.01
1938 to 1939...	4.28	4.17	3.42	4.14	3.95
1939 to 1940...	3.43	3.65	4.45	5.72	4.39
1940 to 1941...	4.19	4.00	3.90	4.18	4.05
1937 to 1941 experience	4.00	3.92	3.91	4.50	4.09
1941 to 1942...	4.44	3.33	3.26	3.90	3.71
1942 to 1943...	2.52	2.18	2.20	2.69	2.40

It will be noted that between 1931 and 1941 the rate remained fairly constant. In



Table VI gives the cases in their respective age-groups for the two periods, 1933 to 1934 and 1941 to 1942. In the latter, the "over 15 years" percentage is three times higher than it was in 1933 to 1934.

TABLE VI.—CLASSIFICATION OF DUNDEE CASES BY AGE-GROUPS.

	1933 to 1934	1941 to 1942
0 to 5 years ...	243 cases = 34.2%	235 cases = 23%
5 to 15 years ...	390 cases = 54.8%	451 cases = 44%
15 + years ...	78 cases = 11.0%	335 cases = 33%
Total	711	1,021

The following table gives the diphtheria notifications in Scotland for a number of years divided into the same three age-groups, the percentage of each group being also included:

TABLE VII.—NOTIFICATIONS BY AGE-GROUPS IN SCOTLAND.

	1932		1939		1940		1941		1942	
Ages	Not.	% of	Not.	% of	Not.	% of	Not.	% of	Cases*	% of
0 to 5 years ...	2,191	24.58	2,400	24.39	3,768	25.22	2,251	19.76	2,061	23.6
5 to 15 years ...	4,774	53.55	5,673	55.56	7,740	51.80	5,608	49.21	3,668	42.0
15 and upwards ...	1,950	21.87	2,047	20.05	3,433	22.98	3,536	31.03	2,998	34.4
Total	8,915		10,210		14,941		11,395		8,727	

\* Corrected notifications not yet available.

In 1941 and 1942, the percentages of the "5 to 15 years" group show marked decreases over those of previous years—whether epidemic or non-epidemic. The "over 15 years" percentages show equally marked increases, having risen since 1939 from 20 to 34.4%. All three percentages for 1942 are, in fact, very similar to those recorded in the Dundee area.

It is tempting to suggest that this change in age-incidence is associated with the mass immunization of school populations carried out during the last two years. Before making such an inference, however, it is well to recall that a somewhat similar feature was the subject of comment thirty years ago by Dr. A. K. Chalmers, the then Medical Officer of Health for Glasgow. In a special note attached to his 1913 report, Dr. Chalmers drew attention to a decrease in the incidence of diphtheria in the "under 5 years" group, and an increased incidence in the "5 to 15 year" group, the change beginning in 1906 and being maintained in each of the subsequent years. "Here," he wrote, "we have an illustration of the spread of an epidemic associated with an alteration in the age-incidence of attack and selecting a later age-period." During 1906 to 1913 no mass immunization was practised and a change in age-incidence occurred. Can one assert that the further change in age-incidence which has made itself manifest in 1941 and 1942 was due to the immunization of a large proportion of school children?

Past experience, says Professor Tulloch, indicates that the members of this "over 15 years" age-group were immune to the endemic varieties of the *B. diphtheriæ*. The possibility, therefore, arises that whilst the mechanism, whereby herd immunity develops, is adequate to protect against endemic strains, it may break down or at least prove inadequate when types of the bacillus which have not been endemic are introduced into the population.

He further argues that the notable upward trend of the age-incidence among the non-immunized during the present epidemic suggests that the herd immunity of the population has for some reason afforded less adequate protection during 1942 than in previous years. A relative failure of herd immunity may be due to a number of factors but there are two which may be regarded as probable: (a) that with the passage of time the immunity level of the population fell; and (b) that the level of immunity adequate to protect the population against infection with some varieties of the causal agent is inadequate in respect of others.

The second of these probabilities has an important bearing on artificial immunization. It raises the question whether, now that the gravis type seems to be spreading throughout the whole country, toxoids used for immunization should contain the products of gravis strains in addition to those already in use.

**Mortality statistics.**—The following table gives the quarterly and annual deaths for each of the twelve years 1931 to 1942. The total for 1942 is considerably lower than any previously recorded in Scotland.

TABLE VIII.—DEATHS FROM DIPHTHERIA IN SCOTLAND, 1931 TO 1943.

Quarter	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941	1942	1943
1st	118	128	89	173	176	122	128	141	110	155	187	115	77
2nd	82	71	76	155	115	81	93	101	79	127	117	57	51
3rd	69	69	74	115	89	79	79	78	77	160	88	49	
4th	87	100	117	140	133	105	126	110	129	235	123	69	
Total	356	368	356	583	513	387	426	430	395	675	517	290	

There can be no question of the severity of the 1940 to 1941 diphtheria epidemic. The second and third quarters of 1940 gave abundant warning of impending events and the fourth quarter's total of 233 deaths was much the highest of any quarter in the twelve years under review. A heavy mortality continued during the first quarter of 1941 but by the spring of that year the worst was over.

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4th	87	100	117	140	133	105	126	110	129	233	123	69	
Total	356	368	356	583	513	387	426	430	395	675	517	200	

of diphtheria have occurred among immunized children although not one of these children has succumbed to the attack. This occurrence has been met with particularly in areas where the gravis type of *B. diphtheriæ* has largely replaced the mitis and intermedius types, a fact which supports the suggestion already made that the products of gravis strains should be incorporated in the toxoids used for immunization.

#### SUMMARY

(1) The Scottish immunization campaign has achieved a considerable degree of success, approximately 800,000 children having been inoculated. (2) In Scotland, diphtheria is at present much more an urban than a rural health problem. (3) The gravis type of *B. diphtheriæ* is now the predominant type throughout a considerable part of the country. (4) A marked increase in the incidence of diphtheria in the "over 15 years" group has taken place within the past three years. (5) The diphtheria mortality figures for the past twelve months are much lower than any previously recorded in Scotland. During the same period, a considerable decrease in the case mortality rate has also occurred. (6) A comparison of the diphtheria cases and deaths recorded in the non-immunized and in the immunized groups of the population indicates that the chances of attack and death among the former are much higher than in the latter. On the average, with present diphtheria immunization methods, a child is not so effectively protected against attack as against death.

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Dr. J. A. H. BRINCKER: I congratulate Sir Alexander Russell on the clear case he has made for mass immunization in Scotland. If anything, he has understated the benefits this public health measure has brought to Scotland. Scotland has the advantage over England and Wales for the returns for immunization are much more complete.

For instance, although our returns show the number of children immunized as three and three-quarter million or 45% of the children from 1 to 15 I estimate that if the returns were more complete they would show that a percentage of well over 50 has been reached and that there is an immunized population of over four million children from 1 to 15 years of age.

Similarly in Scotland the figures for notifications and deaths are corrected and these are recorded in the various age-groups. We in England and Wales are dependent on returns made to us by the local authorities; they are incomplete, the notifications and deaths are not corrected and are not divided into age-groups.

Such calculations as have been made for England and Wales are therefore unreliable and underestimate the benefits accruing to the immunized child. For instance the England and Wales figures tell us that for every one immunized child who is notified as a sufferer there are 5.6 non-immunized sufferers and for every one death in the immunized there were 29 deaths in the non-immunized community. The Scottish figures for 1941 were 1 to 12 and 1 to 411. This difference is undoubtedly due to the incompleteness of the England and Wales figures.

Progress of mass immunization in England and Wales since 1940 has on the whole been satisfactory and as the programme only got into its stride in 1942 the treatment of well over three and three-quarter million children must be considered satisfactory. Success depends entirely on the keenness of the medical officer of health. There are quite a number of areas where immunization of all the children has been effected and all that is left for the medical officer of health to do is to immunize the babies as they attain their first birthday and to provide a "boosting" dose for the immunized child when it goes to school. There are, however, still very many backward authorities. Unfortunately the worst results are found in county boroughs and in densely crowded industrial areas where diphtheria is most prevalent and immunization is most needed. Schools and welfare centres have been found satisfactory places for mass immunization. Directors of education and school teachers have been very efficient missionaries for this work and their advice to parents and their help have procured the treatment in schools and school clinics not only of children of school age but also of their younger brothers and sisters.

Welfare centres have for many years acted as centres for immunizing the child of pre-school age. Many children under 5, however, do not attend these centres; in some areas as many as two-thirds or three-quarters do not do so; by calling at the homes, health visitors have brought the benefits of immunization to the notice of the parents of these children.

The Ministry of Information jointly with the Ministry of Health, and quite independently, the Committee for the Study of Social Medicine, carried out an investigation in 1942. The findings were similar. Most parents knew more about immunization and what it offered than they knew of the dangers of diphtheria. If the local authority provided the means most parents were willing to get their children treated. In many rural areas mobile units were successfully employed. The family doctor is the person who should not only advise the parent of the benefits of immunization, but actually carry out the treatment on the child's first birthday. His help so far has been disappointing. In some areas the family doctor has been helpful; in others no help whatever has come from him.

The Ministry and local authorities are about to embark on another intensive campaign throughout the country with the hope that by the end of 1943 we may obtain the figures aimed at, namely the complete immunization of 80% of all children

1942 (particularly in the second half of the year) a sharp fall took place. In order to examine this decrease in more detail, quarterly percentage mortality rates have been calculated for the past six years. Table XI shows these rates for four years before the immunization campaign and two years after it might be expected to show an effect.

Following the epidemic, the first evidence of a reduction in case mortality appeared during the 3rd quarter of 1941, although it was not perhaps until the 2nd quarter of 1942 that any substantial decrease occurred. During the past twelve months, however, the rates have been only about half the pre-campaign figures. Is this the result of immunization? There is some evidence to indicate that the two are not unrelated although the "lag" in the reduction of mortality seems somewhat prolonged. It might be wise to await complete figures for 1943 before giving a more definite opinion.

*Cases and deaths among non-immunized and immunized.*—The two final tables may be taken as a summary of the results of the immunization campaign, containing, as they do, details of diphtheria cases and deaths among non-immunized and immunized persons during 1941 and 1942. In considering these figures, however, and in attempting to estimate the results of the immunization campaign, one or two points should be kept in mind. In the first place, approximately only one person in 10, on an average, ever gets diphtheria; further, the 800,000 children given toxoid inoculations during the past two and a half years were for the most part children of parents who ordinarily would take precautionary measures to preserve the health of their offspring. It is probably correct to say, too, that many of the children who were immunized were living under conditions less favourable to the spread of the diphtheria germ than those under which the non-immunized find themselves. For instance, considerably higher percentages of the child populations were immunized in rural than in urban areas.

In Scotland diphtheria is at present much more an urban than a rural disease. During 1942, in nine counties and seven burghs, not a single death from diphtheria occurred. In each of seven other counties and in one other burgh only one diphtheria death was recorded, whilst in each of six counties and three burghs only two deaths were recorded during the year. Looking at these 22 counties and 11 burghs on a map of Scotland, it can be seen that, during 1942, diphtheria ceased to be a health problem of any consequence in by far the greater part of the country. In fact the problem is at present confined to the four large cities, Glasgow, Edinburgh, Dundee and Aberdeen, and to parts of two or three counties lying in the industrial belt. It is in those areas that a further drive is necessary if the diphtheria problem in Scotland is to be solved.

TABLE XII.—CASES AMONG NON-IMMUNIZED AND IMMUNIZED.

Year	Non-immunized				Immunized			
	Pre-school	School	Over 15 years	Total	Pre-school	School	Over 15 years	Total
1941	2,766	4,275	3,120	10,161	170	835	31	1,036
1942	1,754	2,271	2,905	6,930	307	1,397	93	1,797
Total	4,520	6,546	6,025	17,091	477	2,232	124	2,833

When it is recalled that the number of immunized children was over twice that of the non-immunized, the two sets of figures form a striking and pleasing contrast. Taking the figures for the pre-school and school groups it seems that in Scotland during 1941 and 1942 the immunized child was eight times less prone to an attack of diphtheria than the non-immunized child. More striking still, the immunized pre-school child was about 20 times less liable to attack than the non-immunized. Moreover, medical officers of health report that among the immunized children who contracted diphtheria the disease was mild and complications were conspicuous by their absence.

It is also worth noting that during these two years over 6,000 cases of diphtheria, or 31% of the total, occurred among persons over 15 years of age.

TABLE XIII.—DEATHS AMONG NON-IMMUNIZED AND IMMUNIZED.

Year	Non-immunized				Immunized				Grand total
	Pre-school	School	Over 15 years	Total	Pre-school	School	Over 15 years	Total	
1941	277	186	52	515	—	2	—	2	517
1942	153	89	37	279	4	7	—	11	290
Total	430	275	89	794	4	9	—	13	807

As regards deaths, the contrast between the non-immunized and immunized groups is even more striking than that in respect of cases. From the combined figures for pre-school and school groups, it seems that a non-immunized child had over 100 times less chance of recovery from diphtheria than an immunized child.

It appears that with present immunization methods the average child is not so effectively protected against an attack of diphtheria as it is against death from that disease. In more than one area, indeed, considerable numbers of the confirmed cases

## Section of Neurology

President—R. M. STEWART, M.D.

[April 15, 1943]

### Electromyography in Clinical Medicine

By GRAHAM WEDDELL, Captain R.A.M.C.

In 1929 Adrian and Bronk showed that the action potentials from voluntary muscle can be recorded by means of a concentric needle electrode. Denny-Brown and Pennybacker (1938) used a similar method in a study of fasciculation and fibrillation of voluntary muscle. We have employed this method to obtain information concerning the electrical activity of voluntary muscle in a number of pathological processes particularly those involving peripheral nerves (Weddell, Feinstein and Pattle, 1943).

By a series of animal experiments, we have established the nature of the electrical activity present in voluntary muscles after denervation by complete crushing of the nerve, and during the course of nerve regeneration until functional recovery has taken place. Further, in one case of muscle denervation by nerve crushing under experimental conditions in man (R.E.P. as subject), the electrical activity was observed until functional recovery was complete. We have found that the action potentials from motor unit activity can be sharply distinguished from those of fibrillation. Using a concentric needle electrode, high-gain amplifier, cathode-ray oscilloscope and loudspeaker, a motor unit action potential takes the form of a broad (5 to 10 millise.), and sometimes polyphasic, spike up to 1 millivolt in amplitude, and is heard as a low-pitched knocking sound in the loudspeaker (fig. 1A). In the early stages of recovery highly polyphasic clumps of sharp spikes often occur. A fibrillation action potential appears as a regularly repeated spike of about 1 to 2 millise. with a height up to 50 microvolts and is heard as a sharp click in the loudspeaker (fig. 1B). It is unaffected by the contractions of neighbouring

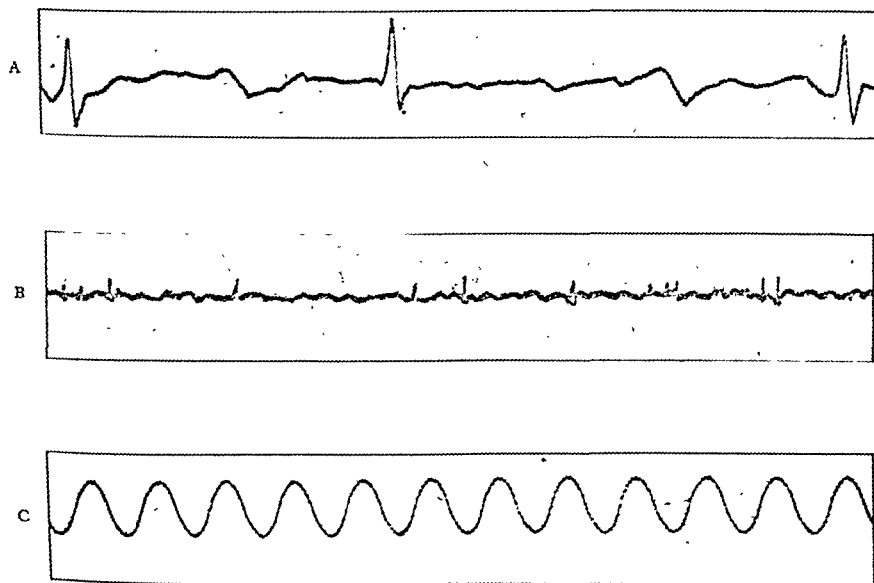


FIG. 1.—(A) A normal motor unit action potential. (B) Fibrillation action potentials. (C) 100 microvolts 50 cycle/sec. A.C.

normal muscle fibres. In normal muscle the insertion of the needle electrode causes an outburst of action potentials typical of motor units. In a denervated muscle shortly before the onset of constant action potentials indicative of fibrillation, the insertion of the electrode causes a transient outburst of spikes typical of fibrillation. Constant fibrillation may cease immediately before the appearance of polyphasic motor units and of signs of

between the ages of 1 and 15. After that local authorities will need only to immunize a number of children under 5 equivalent to the number of births and at the same time reinforce the immunity of those who enter school by one boosting dose.

The prophylactic of choice is now the antigen A.P.T. and this is recommended and provided free by the Ministry of Health. Its preparation has been greatly improved and it should provide a conversion rate of 98%. In the dosage prescribed it should produce no reaction. Some authorities still prefer the antigen T.A.F. for older children and for adults, as it is held that there is less chance of reaction. In a controlled observation carried out in Nottinghamshire with A.P.T. out of 15,500 immunized children only 14% showed a mild erythema, 1.4% erythema with local swelling and in only 0.04% were there any severe constitutional symptoms.

Sir Alexander Russell referred to certain cases of paralysis following shortly after either the first or the second injection of A.P.T. We have had similar experience in this country and these cases have been referred to by Dr. Russell Brain and Prof. Greenfield at an earlier meeting of the Neurological Section of the Society (*Proceedings*, 1943, 36, 319). To show that the process of immunization has any influence on the development of poliomyelitis or other complication it would be necessary to find out whether more cases of the disease occur in the children who are being immunized than in a similar non-treated community. All that can be said is that only a few cases have come to the knowledge of the local authorities and all occurred when poliomyelitis was prevalent in the district.

The post-Schick test is our only satisfactory means of proving that the treatment has had its desired effect. When the Ministry put forward the scheme for mass immunization their object was as a first effort to get the majority of children treated; and to test the conversion rate an experiment was made which showed that this was 98%. Local authorities could not have carried out general post-Schick tests though many of them have already accepted the test as a proof of the efficiency of their scheme; and this is a very wise provision; more especially as the technique employed, the prophylactic used, the period since the treatment was carried out are all variables in the production of immunity.

**Carriers.**—These are persons who are immune to an attack of diphtheria but who owing to certain conditions of their nasopharyngeal make-up, carry virulent diphtheria germs. They carry the virulent germ not because they are immune but because of the state of their mucous membrane. They are cases for the throat and nose surgeon and should not be notified and sent to a fever hospital. There is therefore no logical reason why carriers should be more common in an immunized community. In fact the evidence so far forthcoming is that they are not.

**Age-incidence.**—Long before mass immunization was introduced there were indications that there was a shift of the age-incidence of diphtheria. Sir Alexander has told us that Dr. Chalmers pointed this out many years ago and the Leeds school did the same in the thirties. The evolution of the germ and its variations in type are an interesting study in epidemiology, as has already been demonstrated with the tubercle bacillus and in diseases like influenza, yellow fever and malaria. The Leeds school taught us that the type "mitis" which has a special predilection for the infant and produces laryngeal diphtheria has gradually been replaced by the "gravis" type which prefers the older child's mucous membrane and is more likely to provide the toxic type of the disease.

**Incidence and mortality.**—Much remains to be done to provide records such as are required by the statistician. Finally the records of notification of the disease as returned by the local authorities have not been corrected as they are in the case for Scotland. They include cases both of wrong diagnosis which has been shown to be as much as 25 to 30% of the whole, and of pure carriers of the germ in immune persons. As these errors affect both categories of cases they may be considered as cancelling themselves out. Until, therefore, the clinician can tell us what constitutes an attack of clinical diphtheria in an immunized child and until we have more carefully compiled records and returns the advantages of mass immunization cannot be clearly shown.

Dr. J. L. BURN (Salford) said that the account of the Scottish campaign was most helpful and stimulating. After the special effort of all campaigns, the problem to be faced was the method of securing a higher percentage of immunizations among the new babies coming along year by year. One useful suggestion had been the sending of a decorative birthday greeting card to every baby born within the area on its first birthday.

The shortage of medical man-power raised the question of who was to give the inoculations. In Salford, selected public health nurses had performed these inoculations, with results in no way inferior to those of practitioners and, incidentally, negligible reaction rates. The low reaction rate following inoculations by the public health nurse could perhaps be explained by the time she was able to devote to the scrupulous observance of aseptic technique. It was found better also to employ the nurse for the inoculation of these children whose parents, while consenting to the immunization, were unable, owing to war work, to bring their children to the clinic. Such children could be immunized at home—a procedure also adopted in the case of unimmunized contacts of diphtheria when the nurse was paying the "Infectious Disease Visit". At this time, parents were ready to give consent.

Altogether, the use of the public health nurse had proved satisfactory.

Dr. P. HARTLEY (Hampstead) referred to the potency of the alum precipitated toxoid (A.P.T.) used in this country. While the requirements were now such as to ensure that batches of inadequate potency were unlikely to be supplied for field use, an even greater assurance of their antigenic efficiency would be secured by the establishment of a more logical and scientific method for their laboratory testing. Antigens presented peculiar difficulties to workers in biological standardization; nevertheless, comparative testing in relation to a standard preparation of proved merit, and the statutory requirement that batches intended for use in the field should be at least as effective as the standard in such comparative tests, would be a marked advance on the methods hitherto employed which were based on the production of an animal reaction, no standard being included in the tests. Work on these lines was proceeding in the speaker's laboratory.

[May 20, 1943]

## DISCUSSION ON IMMERSION INJURIES AND VASOMOTOR DISORDERS OF THE LIMBS IN WARTIME

Professor J. R. Learmonth: Vasomotor disorders encountered during total war assume special importance in the surgery of the extremities. When these disorders attend wounds caused by missiles of high velocity, which are characterized by a wide zone of disruption of tissue, the local results of ischæmia are often immediate, extensive and irreversible; while ischæmic tissues may survive the initial insult, only to be destroyed later, or even to destroy life, as a consequence of their diminished capacity to resist infection. Moreover in total war the surgeon no longer deals only with healthy young males, and so with resilient blood-vessels; any age-group of the population may come under bombardment, or be exposed to extremes of cold; and when the patient is old enough to have organic changes in his vessels, he may lack sufficient vascular reserve to tide him over a vasomotor crisis.

The following classification is for descriptive purposes only and does not indicate exact pathological subdivisions.

I.—*Vasomotor disorders resulting from injury.*—A. *Arterial spasm*:—(1) Local—after subcutaneous injury. (2) Of collateral vessels: (a) After arterial contusions, with thrombosis, (b) after division of an artery. B. *Traumatic arteritis*. C. *Traumatic venous thrombosis*. D. *After division of peripheral nerves*.

A. *Arterial spasm*.—Arterial spasm in the vessels of an extremity may be local or general, more commonly the latter. Local spasm may result from an injury to an artery which is insufficient to produce gross changes in its coats, although in my experience it is very difficult at operation to decide the extent of injury. It is likely that when there is macroscopic evidence of significant adventitial injury, there is also present more extensive intimal damage, and the pathological end-result is local thrombosis. The consequences of blockage of a main vessel vary with many factors; in practice the most important are the age of the patient, and the limb affected. The total final arterial input depends on the availability of collateral channels, and this may be materially reduced by reflex vasoconstriction. While pure local spasm is probably a temporary condition, there is no doubt that when spasm involves the general arterial tree it may jeopardize the vitality of the whole or part of a limb. The clinical problem is to maintain the vitality of the tissues, and this may be attacked in two ways: (1) by the avoidance of local heat, which increases local metabolism, and by the application of local cold, which reduces metabolism to a point at which the diminished blood supply is sufficient to maintain vitality; and (2) by attempts to relax the spasm. I have found spasm resistant to periarterial sympathectomy proximal to the lesion, to heating of the body elsewhere in order to produce reflex vasodilatation, and I have seen it occur when preganglionic vasoconstrictor fibres had been interrupted by spinal anaesthesia. In my experience general acute spasm persists in spite of treatment as long as a local arterial lesion is present; and I have found it present in the arm, when all the nerves of the limb save one (the circumflex) had been interrupted. In this instance it disappeared abruptly after removal of a thrombosed segment of the axillary artery. General arterial spasm may also occur after arterial wounds treated by ligation, and sometimes it is curiously selective in its effects: thus in one case, after ligation of the brachial artery in mid-arm, the flexors of the wrist acted nearly normally, although the flexors of the fingers underwent ischæmic necrosis.

In my opinion the possibility of local spasm or local thrombosis is an indication for surgical exploration or re-exploration of the affected artery at the earliest possible moment.

B. *Traumatic arteritis*.—Occasionally in the main arteries of young men thrombiform, the microscopical examination of which suggests a traumatic origin. The clinical features of these cases suggest ischæmia as their explanation, and this is contributed to by reflex vasoconstriction of the collateral tree. In these more chronic cases I have found that preganglionic sympathectomy improves the distal circulation, but the correct pro-



functional recovery. On the other hand when nerve regeneration is not complete some fibrillation action potentials will persist. A variation observed by ourselves and others in the number and frequency of fibrillation action potential spikes in various muscles in the same animal prompted an investigation of the activity of denervated muscle in several types of laboratory animal and in man. The results show that the time of onset of fibrillation activity after denervation is related to the size of the animal and suggests that it is related to the metabolic rate. In the peroneal muscles of the mouse fibrillation begins three and a half days after denervation, in the rat four days, in the rabbit six days, in the monkey eight days, and in man eighteen days. Moreover the transient irritability indicated by the outburst of fibrillation-like action potentials upon insertion of the needle electrode begins correspondingly earlier and follows a similar time course. The metabolic rate was lowered in rabbits by removing the thyroid gland and it was observed that fibrillation action potentials were delayed in onset for about fourteen days after denervation. It has been suggested that fibrillation is not a constant feature following denervation of voluntary mammalian muscle. We have found however that a denervated muscle will invariably fibrillate if it is kept at approximately body temperature; cooling a muscle always decreases fibrillation, and may stop it. It is for this reason that denervated muscles exposed at operation do not always fibrillate.

Fibrillation has been described as a "restless agitation without either apparent rhythm or obvious centre of activity". This description is appropriate for small laboratory animals; it is not accurate for man. We have observed that in man fibrillation does not express itself visually as a continuous rippling of the muscle, but rather as scattered and intermittent contractions of isolated fibres. Our findings show that there is no direct correlation between the degree of fibrillation and the rapidity of muscle atrophy. These studies, with those of Solandt and Magladery (1940) cast doubt upon the theory suggested by Langley (1915-1916) and Tower (1939) that the atrophy following denervation is in part due to over-activity consequent upon fibrillation. The possibility was considered that the variation in the average diameter of the muscle fibres from animal to animal, and even from muscle to muscle in the same animal, might have some effect on the number and frequency of the action potential spikes. A histological study of experimental material failed to show any such correlation. The time, course and frequency of action potential spikes seem to be related to the metabolic activity of the muscle.

It has been found that electrical activity is always present when there is muscle tissue. Where this has been replaced by fibrous tissue, no electrical activity whatever can be obtained.

We have found electromyography to be of aid in diagnosis and prognosis in the following conditions:

In cases of peripheral nerve injury fibrillation action potentials in the absence of motor unit action potentials are indicative of a complete lower motor neurone denervation of the muscle. This is of particular value in those cases where the muscles fail to respond to percutaneous galvanic stimuli. In conditions of muscle weakness and wasting when a partial nerve interruption has occurred, e.g. cervical rib, a mixture of fibrillation and motor unit action potentials is found.

Following regeneration of a peripheral nerve, a mixture of fibrillation and highly polyphasic motor unit action potentials appears before signs of recovery can be determined clinically or before the electrical reactions alter.

The presence more than three weeks after injury of an outburst of motor unit action potentials on insertion of the electrode, and the absence of fibrillation action potentials, indicate that no axons have been severed, e.g. in certain cases of "Bell's palsy". In such cases prognosis is usually good. If fibrillation appears after three weeks, recovery is by regeneration with the development of associated movements. When no electrical activity whatever can be obtained from a muscle, it may be concluded that severe morphological changes have occurred, e.g. fibrosis. This sometimes occurs in peripheral nerve lesions where treatment of the muscle has been inadequate.

In certain cases where denervated muscles are in poor condition and fibrillation action potentials are difficult to obtain, even after warming, prostigmine is valuable in helping to elicit them.

A case of radial nerve palsy was shown, and the fibrillation action potentials from the denervated muscles compared with the electrical activity from the normal side.

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[May 20, 1943]

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Following regeneration of a peripheral nerve, a mixture of fibrillation and highly polyphasic motor unit action potentials appears before signs of recovery can be determined clinically or before the electrical reactions alter.

The presence more than three weeks after injury of an outburst of motor unit action potentials on insertion of the electrode, and the absence of fibrillation action potentials, indicate that no axons have been severed, e.g. in certain cases of "Bell's palsy". In such cases prognosis is usually good. If fibrillation appears after three weeks, recovery is by regeneration with the development of associated movements. When no electrical activity whatever can be obtained from a muscle, it may be concluded that severe morphological changes have occurred, e.g. fibrosis. This sometimes occurs in peripheral nerve lesions where treatment of the muscle has been inadequate.

In certain cases where denervated muscles are in poor condition and fibrillation action potentials are difficult to obtain, even after warming, prostigmine is valuable in helping to elicit them.

A case of radial nerve palsy was shown, and the fibrillation action potentials from the denervated muscles compared with the electrical activity from the normal side.

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were not present. A few hours after landing he was quite better. After this episode he had similar attacks when above 12,000 feet, although he was always suitably clothed. In the third of these, and in subsequent attacks, the medial three fingers of both hands became blanched up to the proximal interphalangeal joints. Four years later, although he had been employed on ground duty only, he was still having similar attacks which were worst in cold weather, particularly in the early morning; and recently the tips of the index fingers had also been affected. The vasomotor responses in this patient's digits showed that the digital arterioles were in a state of spasm; full reflex vasodilatation was not reached until the feet and legs had been heated at 45° C. for fifty minutes (normal fifteen to thirty minutes), although the ultimate skin temperatures (32° to 35° C.) were high enough to exclude any notable organic narrowing of the vessels.

(ii) *Initial "attack" following change of occupation: subsequent repeated attacks.*—A patient aged 25, by occupation a cinema-operator and accustomed to work in a hot environment, went to Army duty in the north of Scotland. In summer, while working on the metal of a high pylon, he had his first attack, in which all the fingers of both hands became first dead white and cold, then blue, then fiery red. During the following winter these attacks became more frequent, and interfered with his military duties. No evidence of cardiovascular disease was found, the fingers reaching full vasodilatation level in the normal time.

(iii) *Previous attacks resulting from use of vibrating tool: accentuation on mobilization with Army.*—This patient, aged 35, had suffered from numbness and coldness of both hands for eight years prior to 1939; his trade was that of shoemaker, and to fix soles to boots he used a mechanical vibrating tool. All digits of both hands were affected, the right hand more than the left. The attacks became more frequent during his Army training, which exposed him to cold and wet; the index, middle and ring fingers were affected in that order of severity, the fifth fingers escaping. The vasodilator responses were less satisfactory in the right hand than in the left, and least satisfactory in the index fingers, where organic changes were already present in the arterioles.

(iv) *Accentuation of previously existing attacks on change of climate.*—A soldier, aged 20, had suffered for six years from blueness, coldness, and swelling of his hands in cold weather. His home was in the south of England, and there he managed fairly well if he kept indoors in winter. His unit in the Army moved to the north of Scotland, and he was much out of doors in cold weather; the attacks became severe enough to interfere with his handling of weapons, and also affected his feet and toes. There was an adequate vasodilator response in both hands.

(v) *Hereditary cold fingers: no accentuation of attacks in cold dry climate; marked accentuation in cold wet climate.*—This soldier, aged 21, had had blue hands all his life. In cold weather they became a much deeper blue. His civil occupation was that of oiler of railway locomotives, and it is of interest that the constant film of oil with which his hands were covered during working hours did not change the nature or incidence of his attacks. A dry cold climate in which he served for two years did not seem to intensify the attacks; indeed he thought the condition of his hands was on the whole less incapacitating. However, on his transfer to a cold wet climate the attacks became more frequent and more severe. There was no evidence of cardiovascular disease, and both hands showed good vasodilator responses.

Abnormal sensitivity to cold and/or wet may greatly reduce the military usefulness of a soldier. In times of peace, one can give advice on suitable clothing, and on the avoidance of the effective stimulus—usually wet cold—which precipitates the attacks; and in extreme cases improve the circulation in the digits by preganglionic sympathectomy. In times of war exposure to cold and wet may be obviated by recommending if possible a transfer to a theatre of war in which the climate is warm and dry; this is the procedure when the technical skill of the soldier is a military asset. In other cases the soldier may be returned to civil life, if his original trade is making a direct contribution to the war-effort; industrial conditions are less likely than military to provide the effective stimuli for incapacitating attacks. In time of war treatment by sympathectomy has a small place in the management of such cases.

C. *Immersion foot.*—The first important point is the scrupulous avoidance of a too rapid return of blood-flow to the chilled parts, whether induced by local heating (e.g. during first aid) or by interruption of sympathetic vasoconstrictor fibres. I have found it useful to nurse these patients on the face, with feet and legs uncovered and elevated, by an open window in default of a fan. The second point is that the surgeon's attitude must be almost rigidly conservative, and this may require much patience. Formal high amputations should be reserved for the rare cases in which gangrene has been extensive, or aggravated by sepsis. The third point is the provision of some form of arch-support in cases

cedure<sup>1</sup> is to remove the thrombosed segment cleanly, and thus to remove the stimulus to constriction of the alternative vessels; the origins of these from the parent trunk must of course be carefully preserved.

C. *Traumatic venous thrombosis*.—It has been suggested by Ochsner and de Bakey (1940) that some of the clinical features of white leg are the result of vasoconstriction of the arterial tree of the limb, reflexly imposed by afferent impulses from the affected vein, and that this may be relieved by interruption of the preganglionic fibres to the limb by paravertebral novocain injections. I have found this procedure of value in a case of traumatic venous thrombosis of the axillary vein.

D. *After division of peripheral nerves*.—After division of a peripheral nerve there is a period, lasting about twenty-one days, during which the area which is analgesic to pin-prick becomes hot, flushed and dry. Thereafter the temperature of the area varies with that of its environment, and it is therefore usually colder than that of normal areas. Such denervated parts cannot be warmed up by inducing vasodilatation reflexly; but the blood-flow in them may be increased by local stimuli, such as injections of histamine (Lewis and Pickering, 1936), and the presence of a focus of inflammation (Richards, 1943). During recovery from peripheral nerve lesions, it is, therefore, important to prevent loss of heat from the affected parts, by the provision of complete warm coverings.

II. *Vasomotor disorders occurring in organic vascular disease*.—A. *Syphilitic endarteritis*. B. *Arteriosclerosis*. C. *Thrombo-angiitis obliterans*.—(1) Of rapid development. (2) Of slow development. (3) Of stabilized type. D. *Paradoxical spasm*.

A considerable number of cases has been encountered, in which the stresses and strains of life in the Services have brought to light previously unsuspected organic vascular disease. The manifestations have been nutritional lesions, including claudication, ischaemic pain in the feet, and vasomotor features such as the appearance of the Raynaud phenomenon in hands or feet. No age-group has been exempt, and I have seen a man of 27 whose initial complaint was coldness of the feet, die in six months from the fulminating type of thrombo-angiitis obliterans, and an old soldier with recurring attacks of blanching and cyanosis of the hands. From a pathological point of view, the most common lesion has been thrombo-angiitis obliterans, and its vasomotor side-effects have been the cause of complaint as often as frank nutritional lesions. Arteriosclerosis has been a much less common diagnosis, and syphilitic arteritis a rare one. A still rarer type, of which we have recently had a second example, was found in a patient whose arteries went into spasm on exercise, so that he complained of numbness and coldness of the feet after a route march, and even of claudication. In such cases examination after exercise reveals cold feet, with absence of pulsation in the dorsalis pedis and posterior tibial arteries, although these vessels pulsate freely after a night's rest under warm bed-clothes.

Most of these patients have been treated conservatively, and some of them can be retained in the Services if they are regraded, and arrangements made for their work to be carried on in a sheltered and if possible warm environment. In a few suitable cases, in which there have been associated nutritional lesions, lumbar sympathectomy has permitted amputations of the trimming variety.

III.—*Vasomotor disorders from local effects of cold*.—A. *Symmetrical syphilitic digital gangrene*. B. *Vasomotor symptoms and signs started or accentuated by*:—(1) Change of occupation. (2) Change of climate. (3) High altitudes. C. *Immersion foot*. D. *Frost-bite*.

A. *Symmetrical syphilitic digital gangrene*.—I have seen two examples of this rare condition, in which the final gangrene was precipitated by exposure to cold. The final cutting off of blood supply is precipitated by leakage of plasma from the vessels: the loose red thrombus which is left acts as a plug.

B. *Vasomotor symptoms and signs started or accentuated by change of occupation, change of climate, or high altitudes*.—This is a numerically important group. The one finding common to all is that, given a digital arteriolar system already sensitive to cold, or one made sensitive by an episode of exposure to severe cold, then the attacks of numbness, blanching or cyanosis tend with the passage of time to occur more frequently, at a higher exposure-temperature and/or after less prolonged exposure.

(i) *Initial "attack" after unprotected exposure at high altitude: subsequent repeated attacks in cold weather at sea level*.—In 1938 an airman, aged 19, went up without gloves. At 12,000 feet he began to suffer a "fierce ache" in his hands and wrists; colour changes

<sup>1</sup> I have treated one patient (who remains well after two years) by preganglionic sympathectomy alone.

D. *Very severe cases with irreversible (degenerative) nerve lesions, usually with gangrene.*—This grade includes groups VIII and IX with sensory loss to cotton-wool at seven to twenty-one days extending to the level of the malleoli or higher. In many cases gangrene prevented complete examination, but cases in which tests were possible showed loss of vibration sense and joint sense in the great toes. Small muscles of the feet were paralysed with wasting and gave impaired responses to electrical stimulation. The feet were blistered. Gangrene was invariably present, and usually involved loss of digits (group VIII); in extreme cases (group IX), gangrene was more extensive, e.g. involving the distal halves of the feet. Oedema usually lasted about seven weeks, hyperæmia three to four months. Tingling and pains usually lasted three and a half to four months. Extensive anæsthesia was present even six months after rescue. The usual stay in hospital was at least six months, and few cases became fit even for light duties. Many cases were complicated by sepsis or had to undergo amputations. Some, at least, developed persistent hyperhidrosis and a cold-sensitive state.

#### VASOMOTOR DISORDERS

For a variable period after rescue, usually not more than a few hours, the feet remain cold. Then rather suddenly the stage of hyperæmia sets in. Most of our observations have been made in this stage, and in the succeeding post-hyperæmic stage.

(1) *Serial observations on skin temperature.*—The length of the hyperæmic stage varies from a few hours or days to fourteen weeks or more, according to the severity of the case. The clinical observations have been confirmed by serial observations on skin temperature. In a moderately severe case (grade C, group V) (described elsewhere as Case A, see Ungley, 1943) skin temperatures were recorded from the tips of the great toes after exposure of the limbs to room temperature. In the first seven or eight weeks, the parts were always hot (30° to 35° C.). Thereafter the state of hyperæmia was less stable and on some days one or both toes were cold.

(2) *Skin temperature gradients.*—After exposure of the unclothed body to room temperature, peripheral parts remain as hot as or hotter than groins. As hyperæmia passes off, normal temperature gradients are restored.

(3) *Vasomotor reactions.*—In the hyperæmic stage, there was at first complete vasomotor paralysis. The toes were hot and showed no significant fluctuations in temperature when the arms were immersed in hot, cold, then hot water.

In a fairly mild case (grade B, group IV) (described elsewhere as Case B, see Ungley, 1943) there was almost complete vasomotor paralysis at eight days. At six weeks, hyperæmia had almost subsided and vasomotor reactions were practically normal. In a moderately severe case (Case A) the stage of hyperæmia lasted much longer. At nine days the left great toe was hot and showed no vasomotor responses. At forty-three days, the toe was hot but slight vasomotor responses were present. At fifty-nine days, the hyperæmic state was no longer stable. On this particular morning the feet had become cold through contact with cold stone floors. Immersion of arms in hot water failed to produce reflex vasodilatation of the left great toe. Warming up, delayed and gradual, occurred subsequently, when the patient was covered with blankets. At eighty-three days, the toe was hot but definite vasomotor responses were present. At one hundred and thirty-nine days, hyperæmia had passed off completely. The sequence of events on immersion of arms in hot water was the same as at fifty-nine days.

In another moderately severe case (right foot group IV, left foot group V), there was gangrene of the left great toe, and the left dorsalis pedis pulse was absent or feeble. When vasomotor responses were finally restored, the slower warming up of the base of the left great toe, compared with the corresponding area on the right side, probably reflected the effects of partial arterial occlusion.

#### SENSITIVITY TO ADRENALINE

In investigating possible causes for hyperæmia in immersion foot, we endeavoured to determine whether the skin vessels in the affected parts showed the sensitivity to adrenaline, which is known to occur eight to ten days after postganglionic sympathectomy, when vasoconstrictor fibres have degenerated (Freeman, Smithwick and White, 1934).

In a moderately severe case (Case A), insulin tests carried out at twenty-nine, sixty-four, eighty-eight and ninety-eight days all showed that the vessels of the great toes were sensitized to adrenaline. Vasoconstriction in the skin vessels of the toes was indicated by a sudden fall of temperature, often amounting to 6° to 7° C.

#### FAN COOLING

As described elsewhere (Ungley, 1943), we have confirmed the observations of Webster *et al.* (1942), that fan cooling the hot feet relieves pain and tingling. Skin

of paralysis of the small muscles of the feet; this should be worn during graduated walking exercise, until these muscles recover power.

I am indebted to Dr. Davidson, Chief Medical Officer to the Department of Health for Scotland, for permission to utilize certain case records.

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**Surgeon Commander C. C. Ungley, R.N.V.R. :** In the first place I shall summarize the main clinical findings and indicate degrees of severity which may occur.

"Men exposed in open boats or rafts, with their limbs immersed in sea water at  $-1.9$  to  $10^{\circ}$  C., may show evidence of damage to peripheral vessels, nerves, muscles and skin. A similar condition may affect extremities exposed to cold without immersion, provided the degree of cold is insufficient to cause frost-bite.

"After a short prehyperæmic stage there is a stage of hyperæmia in which the affected parts become hot, red and painful, more swollen and perhaps blistered. Gangrene, if present, is nearly always superficial. In severe cases the results of nerve degeneration in the cooled tissues are evident in sensory loss, motor, vasomotor and sudomotor paralyses.

"In the post-hyperæmic stage inflammation subsides, vascular tone recovers, the skin temperature falls and the vessels may become hypersensitive to cold. By this time the patient is usually free from swelling, pain and tingling. Complete recovery, which must await regeneration of peripheral nerves, is preceded by signs suggesting partial reinnervation of end-organs and effector organs—cooling (with a cold-sensitive state), partial recovery of sensation (with hyperpathia) and of sweating (with marginal hyperhidrosis).

"Late sequels include recurrence of pain, tingling, swelling or blisters; persistence of a cold-sensitive state or of hyperhidrosis; and occasionally circulatory defects suggestive of vascular occlusion."

(Summary from Ungley and Blackwood, 1942.)

A useful criterion for classifying severity has been the degree and extent of anæsthesia to cotton-wool at seven to twenty-one days after rescue. Cases fall into the following groups:

A. *Minimal cases with no, or at most, transient interference with nerve function.*—Cases had either transient œdema (group I) or transient œdema and tingling (group II), and no anæsthesia was observed seven to twenty-one days after rescue. Œdema and tingling subsided completely within a week. Occasionally pains began in the second week. Some patients were left with cold-sensitive hands and feet.

B. *Rather mild cases with reversible nerve damage.*—In this grade I have included groups III and IV with sensory loss to cotton-wool almost entirely confined to parts of the plantar surfaces of the feet and to the tips of the toes. In the great toes vibration sense was lost. In about 25% of the cases, joint sense was normal or only slightly impaired. Weakness of toe movements persisted for a few weeks, but there was little or no impairment of electrical reactions, and the feet seldom became wasted. Blisters and gangrene were not present. Œdema lasted one to three weeks. Tingling, stabbing pains and hyperæsthesia usually disappeared within two to four weeks. The hyperæmic stage lasted from three to seven weeks. Within six to nine weeks all signs had disappeared and sensation was usually normal or practically normal. Average stay in hospital was six to eight weeks, and men returned to full duty ashore or afloat within three or four months after rescue. Late sequels included excess sweating and a cold-sensitive state in the extremities.

C. *Moderately severe cases with irreversible (degenerative) nerve lesions.*—In this grade I have included groups V, VI and VII. In all of them there was complete loss of sensation to cotton-wool over the plantar surfaces of the feet, and in the most severe, the anæsthesia extended almost to the top of the malleoli. The dorsum and sides of the feet were involved to an extent varying from toe ends to just short of the ankle-joints. In the great toes, vibration sense was nearly always absent, and joint sense frequently much impaired. Power in the great toes was diminished or lost. Small muscles of the feet were weak, wasted and showed impaired responses to electrical stimulation. The feet were blistered in nearly half the cases. In some of the more severe, there was superficial gangrene. Œdema, slight or severe, usually lasted two to three weeks. There was a well-marked state of hyperæmia in all cases, lasting from five to fourteen weeks, according to severity. Tingling lasted six to eight weeks, and pain six to fourteen weeks. Hyperæsthesia might pass off in six or eight weeks, but often persisted for many months. The degree of sensory loss six months after rescue was often considerable. The average stay in hospital varied from nine weeks in the milder cases to six months in the more severe cases. Only about 25% of cases recovered sufficiently to return to full duty, but most of the remainder were able to do light work or office duties. Late sequels included hyperhidrosis in more than half the cases, and a cold sensitive state in more than a third.

a few hours or days up to fourteen weeks or more, according to the severity of the case. Findings in the hyperæmic stage are, in respect of skin temperature gradients, vasomotor reactions and sensitization to adrenaline, comparable with those found after post-ganglionic sympathectomy; the hyperæmia seems to be due, in part at least, to destruction of vasoconstrictor fibres in peripheral nerves. The role of inflammation and of damage to vessels is discussed elsewhere (Ungley and Blackwood, 1942).

At first the skin is invariably hot, but later the hyperæmic stage is less stable: parts which are rendered cold, e.g. by fan cooling, may fail to warm up for long periods, despite attempts at reflex vasodilatation. This phenomenon of delayed warming up may continue to occur in the post-hyperæmic stage, and is probably related to the "cold-sensitive state", which is a frequent sequel to immersion foot. Both may be the result of partial denervation, or partial re-innervation of skin vessels, with sensitization of these vessels to adrenaline, or adrenaline-like substances, and possibly increased sensibility to cold on the part of the vessels themselves.

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Dr. W. Blackwood [Abstract]: The paper recorded histological and experimental findings in immersion foot. The human material consisted of one foot from a man who died half an hour before rescue and of tissues from feet and legs removed from survivors from two to twenty-six months after rescue. In the majority of the surviving cases peripheral sepsis was present. The histological appearances suggested that at the time of immersion damage was done to all the structures in the limb of a degree and to a level dependent upon the length and severity of exposure. In particular, damage was done to nerves and muscle, with some damage to veins. Changes in skin and bone await further study.

The nerves had the greater proportion of their axis cylinders and myelin sheaths killed. Muscles were probably damaged directly. Hæmorrhage from and thrombosis of veins and venules might occur. All these changes were curiously patchy, but increased peripherally. After rescue the nerves began to regenerate. Axis cylinders grew down slowly and myelinization occurred very slowly. Organization and recanalization of thrombus occurred in the veins. Muscle might await re-innervation or be replaced by fibrous tissue.

The experimental work carried out in conjunction with Dr. Russell consisted of exposing the tails of rats to cold artificial sea water for varying lengths of time, and studying the changes after rescue. Patchy damage was found to be produced in nerve and muscle. In rats recovering up to two months the nerves showed persisting partial Wallerian degeneration. The muscles showed acute patchy changes similar to Zenker's necrosis, followed by inflammatory and regenerative processes and later by atrophy due to denervation.

The implication was that early changes in the human may well be similar to those seen in the rats, but early human histological material had not so far been seen.

An account of the experimental work on rats will be published shortly, in more detail, in the *Edinburgh Medical Journal*. It is hoped to submit a paper on the histological findings in human material to the *British Journal of Surgery* in the near future.

Dr. John B. Gaylor said his remarks followed on what Surgeon Commander Ungley had said about the cold-sensitive stage of immersion foot. Vascular tests performed on a patient one year and two years after prolonged exposure in an open boat showed pathological failure of reflex vascular dilatation. One year after exposure it was impossible to elicit any vascular response even when the initial skin temperature was raised to facilitate the reflex. Two years after exposure a slow dilatation occurred reflexly when the initial skin temperature was raised well above that of the environment. At the time of the latter observations the toes were still anæsthetic. This lag in regeneration of cutaneous innervation might be taken as being a direct result of the persistently poor vascularity of cold-sensitive skin.

Dr. Raymond Greene said that one important point was the treatment of frost-bite and immersion foot by various means which aimed at interrupting the sympathetic supply to the peripheral vessels. There had been a spate of papers by French, German and Russian surgeons recommending local novocain infiltration, nerve block, lumbar sympathetic injection and sympathectomy. All these papers described uncontrolled



temperature measurements during fan cooling yielded results of interest which may have a bearing on the mechanism of the delayed warming up phenomenon and of the cold-sensitive state. In Case A at sixty-seven days (Ungley, 1943) we showed that fan cooling could keep the temperature of the toes down for long periods. The chart in that paper shows *gradual* fall which can be obtained by running the fan slowly, well away from the feet. With the fan turned on full 12 in. from the feet, however, there was a rapid and more considerable fall. When, after a short period, the fan was turned off, there was a sharp rise, followed by a more gradual return to the resting level (Case A at forty-eight days). Later when the hyperæmic stage was less stable, cooling the feet with the fan sometimes resulted in the toes remaining cold for a prolonged period, even after the fan was turned off (Case A at sixty-two days, Case B at eighteen days).

### DISCUSSION

Findings in the early hyperæmic stage are, in respect to temperature gradients, vasomotor responses, and sensitization to adrenaline, comparable with those found after postganglionic sympathectomy.

The changes in skin temperature during and after fan cooling are more difficult to explain. An ideal control for these observations would have been a normal limb subjected to postganglionic sympathectomy more than ten days previously, to allow time for adrenaline sensitization to develop. It must seldom happen that normal limbs are subjected to long-term postganglionic sympathectomy, and the best control we could obtain was an acute sympathectomy, induced by a spinal anæsthetic, in a patient with normal vasomotor reactions, and with no sensitivity to circulating adrenaline, induced by insulin hypoglycæmia. As a result of the spinal anæsthetic, the feet, like those during the hyperæmic stage of immersion foot, were hot and dry. When the fan was turned on, there was an abrupt fall of about  $7^{\circ}$  C., followed by a slight and gradual fall. When the fan was turned off, the skin temperature rose abruptly about  $7^{\circ}$  C. This abrupt return to the original skin temperature suggested that cooling had not given rise to any significant degree of vasoconstriction. In this experiment, presumably *all* vasoconstrictor impulses were completely blocked, and there was no sensitization to adrenaline. The results obtained were in sharp contrast with those observed in the hyperæmic stage of immersion foot, in which adrenaline sensitivity has had time to develop, and where interruption of vasoconstrictor fibres is sometimes partial rather than complete.

The hyperæmic state, before it passes off completely, becomes less stable. During this phase, if the feet become cold, they warm up only very slowly, and will not respond reflexly in a normal manner. The phenomenon may persist in the post-hyperæmic stage, as in Case A at one hundred and thirty-nine days. The phenomenon occurred chiefly when the temperature of the parts had been reduced for some time to below  $24^{\circ}$  to  $25^{\circ}$  C. Relaxation of vasoconstriction commonly occurred when the temperature of the parts, having gradually warmed up, reached this same level, i.e.  $24^{\circ}$  to  $25^{\circ}$  C. These findings suggest that there may be a critical level below which relaxation of vasoconstriction is inhibited. Even in normal limbs, local cold may inhibit the reflex release of vasoconstriction, but the phenomenon is not usually observed, unless the initial temperature of the parts is below (and usually considerably below)  $21^{\circ}$  C. In normal limbs, moreover, once release of vasoconstriction occurs, parts warm up very rapidly. Local cold will not explain all cases of failure to warm up. In a case to be described by Gaylor, vasodilatation could not be induced even when the parts were first warmed. Although arterial damage may play a part in some cases, failure to warm up is not entirely due to arterial occlusion: full vasodilatation occurs in response to histamine (observations by R. L. Richards).

The phenomenon of delayed warming up may persist into the post-hyperæmic stage and is probably related to the cold-sensitive state. This cold-sensitive state, a frequent sequel to immersion foot, may be manifested by Raynaud's phenomenon or by coldness of the parts persisting for hours after return from a cold to a warm environment. It is suggested, but not proved, that both the delayed warming up phenomenon and the cold-sensitive state may be the result of partial denervation or partial re-innervation of skin vessels in the extremities, and the sensitization of these vessels to adrenaline or adrenaline-like substances, circulating or produced locally, and possibly to increased sensibility to cold on the part of the vessels themselves.

### SUMMARY

After a summary of main clinical findings and a discussion of the grades of severity encountered, the vasomotor disorders of immersion foot are described. After a short prehyperæmic period there is a stage of hyperæmia, the duration of which varies from

## Section of Obstetrics and Gynæcology

President—Dame LOUISE McILROY, D.B.E., M.D.

[April 16, 1943]

### DISCUSSION ON ANÆSTHESIA AND ANALGESIA IN OBSTETRICAL PRACTICE

Dr. J. E. Elam said that methods of anæsthesia and analgesia must be capable of use under any conditions. Distinction should be made between anæsthesia and analgesia.

Further investigation is needed to find drugs suitable for premedication. The advantages of potassium bromide and chloral are noted because this mixture is safe to administer and reliable in its action. Thirty grains of each are given early in labour, apprehension is relieved and the patient frequently sleeps between the pains. She is more co-operative when an inhalation analgesic is started and the analgesic itself is more effective. Potassium bromide and chloral can be administered by midwives.

The disadvantages of barbiturates are that one cannot predict how the patient may react to their administration: some patients become so sleepy that they will not co-operate with the attendant in the latter stages of labour: some patients become wildly excited and greatly add to the difficulties of the attendant. Some observers consider that barbiturates may depress the respiratory centre of the infant. Barbiturates could not reasonably be administered by midwives.

*Anæsthesia*.—When required before labour, the patient should be calm and every care should be taken to make the anæsthetic as pleasant as possible.

During labour for obstetrical operations gas-oxygen-trichlorethylene sequence had been found valuable, and especially so for Cæsarean section.

Dr. Elam stressed the advantages of the Oxford vaporizer for obstetric practice—trichlorethylene-ether mixture 25% to 75% is used in this vaporizer which could be used as a very safe and simple anæsthetic machine under any conditions in this country.

After the induction by the doctor, the midwife could safely continue the administration.

He went on to say that in *analgesia*, the midwife was the essential factor, as doctors could not be present at all labours or all the time in some labours. Midwives must never be asked to carry heavy apparatus. Machines or gas cylinders could be sent to the house before labour was due. Minnitt's gas and air technique had been found satisfactory but its success depended on attention to details. Sedative drugs were useful early in labour, particularly potassium bromide and chloral. Trichlorethylene analgesia had been found to give satisfactory relief from pain but much further investigation was needed.

Three points were stressed: (1) Need for investigation for more suitable sedative drugs early in labour. (2) The immense value of the Oxford vaporizer for anæsthesia and analgesia. (3) The possibility of the extensive use of trichlorethylene analgesia.

Professor Andrew M. Claye said that up to the outbreak of war he had favoured the combination of intravenous pernocton, a barbituric acid derivative, and scopolamine, for relieving the pains of labour. This was in many ways satisfactory, but on this occasion he proposed to indicate its unsatisfactory features, i.e. a high interference rate (27.5%), a high incidence of troublesome restlessness (20%) and a large number of mildly asphyxiated babies (32.5%). Latterly he had used Minnitt's gas and air apparatus or seconal and chloral in the earlier stages, and a little chloroform at the end, with better results.

observations, and they could hardly be taken seriously in a disease which is notoriously likely to recover of its own accord. One author, Læwen, reported that he obtained no beneficial results. Orloff of Archangel published a paper in which he claimed to have protected the tails of rats completely by novocain injection of the proximal ends six hours after freezing, but his paper contained many points wide open to criticism. For instance he used a method of freezing by which standard results could not be obtained. Dr. Greene used a method of freezing by which standard damage could be done and he had failed to do any good by novocain injections of the tails of mice. He had also experimented on human volunteers, and had produced small areas of frost-bite on the forearms, surrounding one side with novocain and leaving the other as a control. On others he had frozen small areas on the fingers and had given a median and ulnar nerve block on one side. Neither method had significantly affected either the onset of blistering or the ultimate damage. With the assistance of a surgical colleague, he had frozen the hind limbs of a few cats with carbon dioxide and acetone and then had done a lumbar sympathectomy on one side. Either complete recovery or equal damage occurred. He did not want to lay too much stress on these few experiments, but he would be surprised if further work contradicted them. The method seemed to be based on a fallacy. Commander Ungley's work showed that the cold had performed a postganglionic sympathectomy. Therefore, until regeneration began, nothing would happen as a result of further interference, whether this was preganglionic or postganglionic. In the later stage of cold sensitiveness, which corresponds to that of partial renervation, there might be some point in turning a postganglionic into a preganglionic sympathectomy. It was sometimes said that an increase in the calibre of the vessels, supposing this to be possible, might dislodge a stasis column and so free the circulation to distal tissues, but it might equally well be argued that an increased arterial supply might increase transudation from the damaged vessels and so do more harm than good. However, patients were rarely seen before dilatation was already maximal, and there was a mass of evidence which suggested that it was at that stage that most of the acute damage was done.

Sir Thomas Lewis spoke of the enterprising way in which the present wartime opportunity was being seized and of the importance of the observations which were being made on immersion foot, observations which Professor Learmonth, Commander Ungley, and Dr. Blackwood had so interestingly displayed. He emphasized that there was now in these and correlated observations abundant and direct evidence that cold, *qua* cold, damages the tissues of immersed limbs; that the damage is proved to be the greater the longer the exposure and the greater the degree of cold; and that sooner or later the damage affects all tissues, skin, muscle, blood-vessels and nerves. From what previous speakers had said, it affects the vasomotor nerves and leads to paralysis of these like other nerves.

In considering sympathectomy as a remedy for immersion foot it was important to realize that this seems to have been advocated chiefly for a particular phase of recovery; not for the initial hot phase, but for a rarer and algid phase of later phases of recovery. In some such cases there appeared to be evidence of a spasmodic state of the main artery of the limb. Both here and in thrombosis of the vessel, decortication or arterectomy was also being advocated, and the hypothesis put forward that these procedures are capable of breaking down a reflex constriction of collateral vessels.

It should be recognized that there is no physiological sanction for proposing such a reflex. The fact was that releases effected by arterectomy would, if confirmed, be an important addition to knowledge and would be acceptable as such, irrespective of hypothesis; but the hypothesis put forward would require physiological sanction or proof and this it could not yet be said to have received.

[May 21, 1943]

## Phases of Maturation, Fertilization and Early Development in Man

By W. J. HAMILTON

(Anatomy Department, St. Bartholomew's Hospital Medical College, London),

GLADYS H. DODDS and JOSEPHINE BARNES

(Obstetric Unit, University College Hospital, London)

A METHOD for obtaining and photographing living ova was discussed.

An unsegmented human tubal ovum at the stage of the second maturation spindle was recovered on the 17th day of the menstrual cycle. The previous menstrual cycle to that in which the ovum was recovered was of 30 days' duration. The ovum was surrounded by the corona radiata cells and the zona pellucida appeared as a structureless membrane. The light yellowish, refractile vitellus completely filled the zonal cavity in the living ovum. On histological section the second maturation spindle is present.

A second ovum was recovered on the 16th day of a presumed 28-day cycle. The ovum was free from cumulus cells and many sperms were seen in the zona pellucida.

The third specimen, an embryo partially implanted in the uterine endometrium, was found after hysterectomy on the 25th day after the beginning of the last menstrual period in a woman who had a cycle of 28 days. The embryo, partially covered by uterine epithelium, projected as a small elevation from the posterior uterine wall. The trophoblast is differentiated into a cytotrophoblast and a syncytiotrophoblast; the latter is thickest over the embryonic pole of the chorionic vesicle. An amniotic cavity is present and a yolk sac is in the process of formation. The embryo is estimated to be 10½ days old, and the time of ovulation in woman was discussed.

[A full account of this paper appears in the *Journal of Obstetrics and Gynaecology*, 50, 241, August, 1943.]

## DISCUSSION ON THE PRESENT POSITION OF THE LOWER SEGMENT CÆSAREAN OPERATION

Mr. C. McIntosh Marshall: In the following remarks I wish to be clinical rather than academic. Nothing has yet happened to disturb my own faith in the transverse lower segment intraperitoneal operation provided that in suspect or infected patients the incision is made really low, sutured with the greatest accuracy and placed retrovesically at the end of the operation. With the use of local anaesthesia, a full employment of glucose, plasma, and blood infusions, sane and timely treatment of post-operative shock, ileus, and infections with the great means now at our disposal, the mortality need only be minimal. *The rival operations:* Hysterectomy for the infected patient has not been unusual in certain American and Continental clinics; but it is not an absolute safeguard against peritonitis and I feel that many uteri have been needlessly sacrificed for the sake of a very few patients who may possibly, though it can never be proved, owe their lives to such a radical procedure. But we in this country must at least notice the extra-peritoneal procedures (Latzko, Waters, Ricci) and the advantages they may yet have to offer. Cosgrove and Norton (1942) using the two former methods had a mortality of only 1.9% in 209 operations in patients who had all been in labour more than twenty-four hours, with membranes ruptured, and had undergone many vaginal examinations. Their results can be profitably compared with those in a similar group of operations to be presented by Miss Mayeur. *Anaesthesia:* Nothing has occurred since 1939 to shake the conviction I so firmly stated then, that local anaesthesia is by far the safest method in Caesarean section. Manahan (1942) states that among 38 deaths 4 were due to anaesthesia, Mohler (1943) admits that in 11 deaths from shock in 1,322 operations he cannot be sure that the anaesthetic (gas and ether) was not the responsible factor. It is my opinion that in 1,612 sections in the Liverpool Maternity Hospital between 1932 and 1941 anaesthesia was the cause of death in 0.4%. I cannot too strongly urge the wider use of local anaesthesia in at least all those patients who for one reason or another are regarded as poor risks. I earnestly recommend those who are doing large numbers of sections to consider the literature that is rapidly accumulating on this form of anaesthesia (Beck, Gordon, Hollar, Marshall and the many contributions by DeLee and Greenhill, et al.). *Placenta praevia:* I have now been able to deliver by the lower segment

He summarized recent American work on the effect of analgesics and anæsthetics on the infant. He thought that Schreiber, who maintained that brain damage could often be ascribed wholly or in part to the use of analgesics, had not proved his case. He agreed with Kotz and Kaufman, who attributed such brain damage to faulty obstetric manipulations rather than to drugs. The Americans had shown that nitrous oxide in high concentration (85% or more) caused anoxæmia to a degree that was dangerous to the child. Ether and ethylene and nitrous oxide in lower concentration did not appreciably affect the incidence of asphyxia. Cyclopropane also appeared safe. Chloroform did not affect oxygen saturation in the fœtus, but was not advised because of its toxic effects in the mother. Of the analgesics, morphine was the least safe, and there was a fairly high incidence of asphyxia with paraldehyde. The barbiturates in common use had no harmful effect on the fœtus.

He concluded by saying that the safest analgesic was gas and air, as given in Minnitt's and similar apparatus. If a more difficult method were chosen, then its user must acquire the necessary skill: when this was attained disaster was avoided. He hoped that an intravenous analgesic would be discovered which lacked the disadvantages of pernocton.

Dr. Dick Read spoke of the relief of pain in uncomplicated labour. He deplored the routine use of anæsthetics and drugs because a high percentage of women neither desired nor needed them.

The causes and manifestations of the pains of labour were not generally understood by obstetricians. There was no evidence that natural childbirth was designed to be painful. Midwives attended 70% of normal deliveries in the country; the majority used no anæsthesia. The teachers of midwifery, however, attended less than 1% of all normal deliveries. Practically all their patients had anæsthetics and drugs.

The statistics of midwives compared favourably with those of medical men. The distress of labour was due to the pain-fear-tension syndrome, and the best way to relieve pain was to break down the vicious circle of that syndrome. If the fear of childbirth was destroyed by education and instruction and the tension of mind and body relieved by the teaching of relaxation, normal sensations of parturition were not interpreted as agonizing. Pain was the interpretation of stimulus. It was easier and safer to introduce for the relief of pain a mental process than a dangerous drug.

Such preparation for labour was being carried out in many antenatal clinics and had proved its value. If pain was minimized in this way, a discreet use of morphia in the first stage and gas and air in the second, was sufficient to overcome any unbearable discomfort, with little danger either to mother or child.

All women should have "self-administered" apparatus within their reach to use should they have any pain, but women who were well informed in the phenomena and conduct of their own labours frequently preferred to have their babies naturally, without the use of either anæsthetics or analgesics.

Miss Lucy B. Young (Supervisor of Midwives, Middlesex County Council) outlined the use being made of gas-air apparatus by midwives in practice.

Mr. R. H. Paramore referred to the advantages of spinal anæsthesia in obstetrics.

Dr. A. Freedman reported on the administration of trichlorethylene and air to 150 patients during labour.

Dr. B. A. Sellick reported on 251 cases of labour in which the anæsthetic used was intravenous pentothal.

Dr. B. Gallen reported on 75 cases in which a new analgesic, viz. pethidine hydrochloride, was used during labour.

Mr. C. Scott Russell suggested that as gas analgesia is widely used in institutional midwifery by somewhat inexperienced administrators all apparatus should have a summary of instructions attached to the machine.

In reply, Dr. Dick Read said that he did not expect to persuade those who had not witnessed this method of relieving pain in labour. Those who had seen it and practised it needed no persuasion. He would, however, like to invite those present either to talk with women who had experienced it, or to make themselves familiar with the technique. He believed if they seriously applied the method in fifty consecutive cases, they would be less anxious to experiment in the uses of new anæsthetics, drugs and induction apparatuses.

spinal anaesthesia. One mother died (infective endocarditis) and two infants (prematurity). *Toxæmia of pregnancy*: In 41 patients with pre-eclampsia, chronic nephritis, or hypertensive disease, there were no deaths and the foetal mortality was 14.63%. Two mothers suffering from acute yellow atrophy died, but the infants survived. Local anaesthesia was used in 25, inhalation in 6, spinal in 12. *Suspect and infected patients*: The practice of the hospital in regard to this group is easily defined. If it is thought that the strain of vaginal delivery will be fraught with grave mechanical difficulties or that the risk to the life of the child will be more than minimal then the abdominal route is chosen, irrespective of the duration of labour, the condition of the membranes, previous vaginal interference or the presence of suspected or declared infection. Approximately half the patients had fever at the time of operation. In this group were 296 operations. Eight mothers died, a m.m. of 2.70%. The f.m. was 7.43%. Maternal morbidity was 42.90%. The maternal deaths were due to general peritonitis (3), aspiration pneumonia (1), septic thrombophlebitis (1), post-partum hæmorrhage (1), shock following operation for relief of fæcal fistula some two months later (1), perirectal suppuration from perforation with an enema nozzle (1). Of the cases in this group 271 patients were in labour more than twelve hours, 128 were in labour more than thirty-six hours. Operation had been preceded by surgical induction of labour (35), artificial rupture of membranes (17), attempts to deliver with forceps (22, no deaths), attempted version, &c. (10). The maternal mortality in this group was 2.38%.

In the entire series local anaesthesia was used in 365, inhalation in 383 and spinal in 430 instances.

**Professor Munro Kerr**: My confidence in the classical incision for Cæsarean section was shaken when there was brought into my ward a case of rupture of the uterus through the scar of a previous Cæsarean section performed in the classical manner. Following this there cropped up cases in which the scar was observed to be thinned out at subsequent operation. It was in the second edition of "Operative Midwifery" published in 1911 that I first drew attention to the insecurity of the classical incision no matter how carefully the suturing might be carried out; and suggested that another region of the uterus might have to be selected for the incision. A year or two later I performed my first lower segment operation.

I was, of course, familiar with the writings of Kehrer and Frank and Latzko, Döderlein and Sellheim, but at that time the particular technique each employed was primarily directed against infection, while my concern more particularly was with the insecurity of the scar in the classical operation.

The work which helped me most in devising my technique was Barbour's "Anatomy of Labour". This classic in obstetrics is a study of the parturient canal during labour based on frozen sections of women who died during labour or the puerperium. There you can see illustrated the exact anatomical conditions of the parturient canal at all stages of labour. It seemed to me obvious that the lower segment must be the ideal site for the uterine incision—a thinned-out wall free of larger vessels with a special arrangement and distribution of muscular and fibrous tissue and easily covered with peritoneum. These figures from Barbour's monograph and in other papers published mostly in the *Transactions of the Edinburgh Obstetrical Society* directed me not only to the site of the incision but to the direction in which the incision should be made. I never have employed the vertical incision—because on anatomical and surgical grounds it is obviously inferior to the transverse incision.

To my mind the only objection that can be urged against the lower segment operation is that it is sometimes a little more difficult to extract the child and consequently an injury might be done to it by an inexperienced operator. [Some pictures were then shown on the screen illustrating the advantages of the lower segment operation on both anatomical and surgical grounds.]

**Dr. Ninian Falkiner**: Since 1926 the lower segment sections have been regularly reported in the Rotunda Hospital Reports. Between the years 1926 and 1942, 679 sections were performed in the hospital and of that number 412 have been lower segment operations.

The maternal mortality is just under 3% for these 412 operations. Personally I have performed 124 lower segment sections since 1940 and there has only been one maternal death and that death resulted from pneumonia from which the patient was suffering previous to operation.

I still do classical sections but reserve the operation for cases where rapid and easy delivery of the foetus is particularly necessary. Up to last year I had dealt with placenta prævia cases requiring section through the upper segment but have now adopted the lower segment route.

operation in the Liverpool Maternity Hospital 56 patients with placenta prævia without maternal mortality. For the best results the watchwords should be—no delay, use local anæsthesia. In many instances (34 in my series) the typical history, the character of the blood lost, and the abdominal signs warranted the diagnosis of a central or partial placenta prævia without recourse to a digital examination and its well-known disadvantages; in 31 of the 34 cases diagnoses so made were proved correct. If the above advice is followed transfusion will be rarely necessary. *Post-operative complications:* Cesarean section is an operation in which the risks are liable to be cumulative. They must be faced at least once and possibly two, three or even four times. There are only two to which I refer here; they are *ileus* and *dehiscence of the abdominal incision* and both, though rare, will appear on several occasions among any large series of sections. If ileus does not yield to the stoppage of all intake by the mouth, gastric syphonage and intravenous glucose drip, then I have never been failed by the passage of the large stomach tube, liberal lavage, and the passage of two ounces of castor oil down the tube; even with the greatest degree of distension and distress the bowels have always acted within eight hours. Concerning dehiscence of the abdominal incision I wish to direct attention to the pathognomonic sign that the parietal peritoneal suture has given; it is a profuse sero-sanguineous discharge which rapidly soaks the dressings, and stains them characteristically—a pinkish red centre with a straw-coloured serous surround. Even if the superficial layers of the incision remain intact, these patients, if followed up, will eventually show an incisional hernia. The sign is a warning and deserves more attention than it has received.

*Slides shown:* Uterus excised following fourth operation, showing how "lower segment" in the early puerperal uterus is mainly a feature of the anterior wall; two placenta with intact amniotic sacs from cases of placenta prævia in which the infants had been extracted through centre of placenta. *Films shown:* Use of the Pfannenstiel incision in extreme obesity with abdominal apron of fat; miniature lower segment operation on 26 weeks uterus; the pathognomonic sign of dehiscence of the parietal peritoneal incision with typical staining of dressings; resulting incisional herniæ in two such patients; finally a colour film of the various ways of opening lower segment and delivering the infant to demonstrate simplicity, small amount of bleeding, and that in many instances the incision can be completed without rupturing membranes.

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Miss M. H. Mayeur: In the Liverpool Maternity Hospital between 1932 and 1941, 1,178 transverse lower segment operations were performed by 12 operators. The maternal mortality (m.m.) is 1.36% and the foetal mortality (f.m.) 6.54%. The operations are considered in several groups. *Patients of favourable omen:* all the 646 were in good physical condition, and the operation was performed before, or early after, the onset of labour. The chief indications were previous section, disproportion and/or contracted pelvis, obstetric history, &c. The m.m. was 2 (0.31%) and the f.m. 3.73%. The causes of the maternal deaths were staphylococcal septicæmia (1), post-operative hæmorrhage and shock (1). *Placenta prævia:* There were 124 operations, only one classical section being performed for this condition in the last five years. Local anæsthesia was used in 65, inhalation in 20, spinal in 39 instances. The m.m. was 3 (2.42%) the f.m. 18.55%. One death was due to post-partum hæmorrhage, one to diabetic coma, and the third occurred in a patient who had had repeated anæsthetics, many vaginal examinations and treatment by Willett's forceps. Only five patients (4%) required transfusion before or after operation while of 113 patients treated by other methods transfusion at some time or other was necessary in 12.8%. Apart from vaginal examinations (71 patients) there was previous interference in eleven, Willett's forceps (2), vaginal packing (3), attempted stomach tube induction (4), artificial rupture of membranes (2). *Heart disease:* There is no general agreement concerning the best treatment of pregnancy complicated by some degree of cardiac decompensation; but whenever section is performed on this indication all the staff are agreed on the great advantages of using local anæsthesia. There were 69 operations of which 44 were carried out under local, 3 under inhalation, and 22 under

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forceps or other means of traction. A hand is passed into the opening, the presenting part is lifted upwards, while the fœtus is delivered by strong pressure on the fundus.

After the placenta has been removed, two to three mg. of ergometrine are injected into the uterine muscle to promote tonic contraction. The uterine incision is closed with a series of interrupted stitches, beginning at the upper angles and proceeding to the apex, great care being taken to identify the lower edge of the incision and the cervical canal. The peritoneum is closed by a continuous stitch as the series of clamps are removed. The peritoneum, at the fundus of the bladder, is caught up with two or three turns of catgut and anchored to the suture line in the parietal peritoneum. The abdominal incision is closed in the usual manner.

If the case has been one of potential infection, the extraperitoneal space may be soaked with glycerin before the uterus is opened, and dusted with sulphanilamide powder before the abdomen is closed.

[June 18, 1943]

## A Case of Pregnancy Complicated by Convulsions due to Cysticercosis Cellulosæ

By NORMAN H. ASHTON, M.R.C.S., L.R.C.P.

(Director of Pathology, Kent and Canterbury Hospital)

CYSTICERCOSIS in England is of itself an uncommon disease but the great interest of this case lies in its association with pregnancy, for in addition to the fits the patient also had albuminuria so that her condition superficially resembled eclampsia. It is probably the first case of its kind to be reported in this country.

*Historical note.*—In 1933 Colonel MacArthur directed attention to the occurrence of cysticercosis cellulosæ in Service men returning from abroad. He concluded his paper, (*Trans. R. Soc. trop. Med. Hyg.*, 1933, 26, 525), by saying that "the onset of epileptic seizures in a previously normal adult during or after residence abroad, should suggest the possibility of this condition".

*Ætiology.*—"As is well known, the cysticercus or bladder worm stage of *Tænia solium* normally develops in the pig, and infestation of man by the adult tapeworm is due to eating pork thus infected. Occasionally, however, man serves as the intermediate host through the accidental ingestion of tapeworm eggs, and the resulting embryos show a peculiar predilection to invade the brain. Although the beef tapeworm, *Tænia saginata*, is a much commoner parasite of man, there appears to be no satisfactory record of human cysticercosis due to that helminth" (MacArthur).

*Case report.*—Female, aged 43. Admitted to Kent and Canterbury Hospital, March 1943, in the eighth month of her sixteenth pregnancy, there having been thirteen normal labours and two abortions. She was in a semi-comatose condition and was having typical epileptiform fits about every fifteen minutes. She had not vomited. No history was then available so that eclampsia or status epilepticus had to be considered.

*On examination.*—Stuporose and sweating profusely. Pulse 96 and of good volume. The blood-pressure was 130/90. Pupils equal and regular. There were no retinal hæmorrhages and no papillœdema. It was not possible to obtain the reflexes as the patient was unco-operative and moved about continuously. The respiratory and cardiovascular systems were normal and there was no œdema of the sacral region or of the ankles. Eight months pregnant; presentation normal. Urine: albumin present, but a microscopical examination revealed no abnormality; blood urea was normal.

Idiopathic epilepsy, therefore, seemed the most likely diagnosis and she was given intravenous luminal. Fits continued at hourly intervals, there was no return of consciousness between attacks and she was incontinent. Two days after admission she went into precipitate labour and was delivered of a normal male child but unfortunately collapsed after a severe post-partum hæmorrhage and died before a transfusion could be given.

*Post-mortem.*—The first abnormality to be noted was the presence of two small cysts on the anterior surface of the heart. The liver and kidneys showed no evidence of eclampsia. In the brain numerous small nodules were seen scattered over the surface, and cut section showed them to be thick-walled and about the size of dried peas, situated either in or just outside the grey matter of the cortex or basal ganglia. The cysts were not calcified. The diagnosis of cysticercosis was now quite clear and the muscles were carefully examined. Calcified cysts were found embedded in the muscles of the upper

The technique used has been: General anaesthesia. Catheterization immediately prior to operation. Subumbilical mid-line incision. Careful packing off of the intestines. Insertion of a large Doyen's speculum. Transverse incision of the peritoneum at bladder reflection. Pushing down of the bladder. Transverse incision of the uterus with scalpel down to membranes. Enlargement of incision with scissors. Delivery of the head, with hand if possible, alternatively by one blade of the forceps used as a vectis, or by applying forceps. Very occasionally a moulded head which has descended low in the pelvis has had to be pushed up by a second assistant who introduces a hand into the vagina.

When the baby is delivered: Pituitary extract (10 units) is injected into the uterine muscle. The angle stitches are very carefully inserted and the wound in the uterus defined. The placenta is then delivered. The uterine wound is closed in two layers with continuous catgut. The visceral peritoneum is then closed over the uterine wound, taking care that no sponge is covered over in so doing. A careful watch on wipes is necessary all the way through in this operation. The abdomen is then closed.

Before the patient leaves the theatre the problem of the immediate post-operative treatment is discussed. Oxytocics, salines, blood transfusion or chemotherapy are then ordered if indicated.

**Mr. C. Scott Russell:** As mortality from Cæsarean section has now been reduced to the region of 1%, attention must be directed to maternal morbidity in the widest sense. The mortality figures must not now be used as the yardstick by which further progress and improvements in technique are to be assessed. As morbidity improves, so mortality will decrease. I deprecate Mr. Marshall's rather free use of Cæsarean section for placenta prævia; this condition is one which tends to be overtreated. I would recommend a wider use of simple rupture of the membranes except for cases clearly requiring operation. For these the lower segment approach gives good exposure of the placental site, enabling the surgeon to decide more easily than with the upper segment approach which cases require packing. Tearing the lower segment rather than cutting is of value if the placenta is encountered underneath the uterine incision.

**Professor Andrew Claye (Summary):** I think the time is ripe for another widespread inquiry into the results of Cæsarean section, similar to that conducted by Holland and Kerr in 1921 (*J. Obstet. Gynec.*, 28, 358).

The risks and advantages of the lower segment operation are not at present seen in correct perspective; specially good results by individual operators have been published; less satisfactory results have remained unreported. Rupture of the lower segment scar is probably a rarity, but one has been seen in Leeds. The inquiry should also cover the classical operation, and a large body of statistics be made available in order to arrive at a clear conclusion.

**Dr. J. Lyle Cameron:** *Lower segment Cæsarean section by extraperitoneal technique.*—The procedure has all the advantages of the lower segment operation with the additional benefit of exclusion of the peritoneal cavity. By this means the ingress of septic material into the peritoneal cavity can be prevented completely. This would therefore render it more widely applicable, especially to those cases which might be considered potentially infected, such as those which have been long in labour, with the waters drained away for some time, and upon whom intra-uterine manipulations have been made.

The essential steps of the operation are as follows: the skin, fat and aponeurosis of the abdominal wall are divided in the mid-line, starting below the umbilicus and carried well down to the symphysis. The peritoneum is not opened, but is separated from the back of the rectal sheaths on both sides. The wound edges are covered, and well retracted.

The patient having been placed in the Trendelenburg position to permit the foetus to slide upwards out of the pelvis, the head being further pushed upwards through the uterine wall, the lower part of the peritoneal sac is freed on both sides of the bladder, and lifted up by the fingers which are passed from side to side, underneath the peritoneal sac and the bladder. The peritoneal sac is now clamped, and divided transversely by applying a series of long-jawed artery forceps in succession and dividing the peritoneum below them. A small portion of the peritoneal sac remains attached to the bladder, which is pushed well downwards and held with a retractor. The series of clamps keep the peritoneal cavity closed.

The foetal head is held well upwards with the left hand, while the lower uterine segment, now freely exposed, is opened by a V-shaped incision, with its apex well down towards the external os, and the upper arms extending well medial to the uterine vessels. This opening is free and permits the foetus to pass easily, without the employment of

locate the disaster and take steps to remedy it. The appendix was often greatly raised, sometimes as high as the rib margin.

He referred to those cases in which an acute precipitation of cholesterol sand or dust occurred in the gall bladder. It caused acute agony. The proper course after emptying the uterus was to open the gall-bladder, evacuate the sand, wash it out clean and sew it up again. Intestinal obstruction with advanced pregnancy was a very serious thing and here again as a rule the uterus should be emptied as the first step in the operation. He recalled a case where forty-eight hours after delivery the patient rotated her entire small intestine as one huge volvulus.

Mr. V. Zachary Cope said that acute abdominal disease in women differed from that in men by reason of the presence of the female generative organs and the extra path of infection. The chief symptoms—pain, distension, muscular rigidity, vomiting—varied slightly in the two sexes. Pain in most gynæcological conditions started in the hypogastrium but might shift upward; in most conditions in the male the initial pain was central but might shift to the lower abdomen.

Distension was less common in gynæcological conditions. He had, however, known a surgeon make a mistaken diagnosis of intestinal obstruction in a case which was really one of uræmic distension and vomiting, consequent on a nephritis due to the taking of lead with a view to the procuring of abortion. The urine should always be tested for albumin. Rigidity was not found so early in cases of peritonitis starting in the pelvis, e.g. salpingitis and pelvic appendicitis. Voluntary muscular rigidity was more common in nervous women. Vomiting was quite frequent in pelvic peritonitis, ovarian cyst or fibroid with twisted pedicle, and in severe dysmenorrhœa. More than two-thirds of cases of hypogastric pain in women were due either to appendicitis or adnexitis. The common diagnostic problem therefore was to distinguish between these conditions. If the appendicitis was typical there was little difficulty, but when there was no initial central pain appendicitis might be very difficult to differentiate from salpingitis. Moreover it might be almost impossible to be sure whether a tender lump on the right side of the pelvis was a subsiding appendicular inflammatory mass or a pyosalpinx. Severe dysmenorrhœa when accompanied by vomiting could be taken for a more serious condition. On the other hand a recent case of sigmoid volvulus in a girl of 18 gave rise to spasmodic pain felt in the lumbosacral region and made him think at first that he was dealing with severe dysmenorrhœa.

Severe pain, more often on the right side, might accompany ovulation and closely simulate appendicitis. When an ovarian cyst or fibroid twisted on its pedicle the pain and vomiting might be severe but a tumour would be felt. Diverticulitis was protean in its manifestations and must always be considered in inflammatory conditions of the lower abdomen in women. Pneumococcal peritonitis might also occur though rarely in adult women, and with its pain, vomiting, distension and *absence* of rigidity might simulate intestinal obstruction.

Intra-abdominal hæmorrhage might result as a consequence of the rupture of a tubal gestation, but it might also follow from the rupture of a graafian follicle or corpus hæmorrhagicum. One must always recollect that such bleeding might be accompanied by pain on top of the shoulder (phrenic shoulder-pain). The signs of anæmia were not always so evident because of the make-up so prevalent to-day.

With regard to treatment Mr. Cope said that acute salpingitis could usually be treated conservatively especially now that we possessed drugs which had a specific action on the gonococcus. If the abdomen were opened and an early acute salpingitis found it was not necessary to remove the fallopian tubes. As a general rule he treated cases of acute abdominal disease in the pregnant woman much in the same manner as if she were not pregnant. The life of the mother was the more important. In most cases the pregnancy continued normally.

Mr. L. Carnac Rivett said that he had seen a case of carcinoma of the rectum and another case of intussusception in a woman of 40, to both of which he was called on a diagnosis of twisted ovarian cyst. In each case a tense, tender mass could be felt by abdominal and vaginal examination.

He had seen several cases of tubercular peritonitis which had simulated twisted ovarian cysts. Sometimes the differential diagnosis was very difficult because it was not possible to get a correct history. For some reason which he had never been able quite to make out a woman frequently failed to notice a large tumour in the abdomen, so that when the case came for examination a tumour as large as a football was found and no history was forthcoming as to how long it had been there. If it was tubercular peritonitis undergoing an exacerbation of activity, operative interference would produce an acute miliary tubercle which was likely to be fatal.

arms, thighs and in the pectoral region. X-ray photographs were taken to demonstrate that this condition could have been diagnosed in life.



FIG. 1.—Section through a cyst of *Tenia solium* from the cerebral cortex. The parasite is dead and disintegrating, and is surrounded by a fibrous capsule and a zone of inflammatory reaction.

passage of toxins through the dead cyst wall and also by the distension of the cysts which follows the death of the parasite.

I am indebted to Dr. I. H. K. Stevens for the clinical notes.

## DISCUSSION ON THE DIAGNOSIS AND TREATMENT OF THE ACUTE ABDOMEN FROM THE GYNÆCOLOGICAL POINT OF VIEW

Mr. Victor Bonney, opening the discussion, sketched some of the principal causes of acute abdomen as they affected the gynæcological surgeon. As regards acute salpingitis he had always advocated early operation and though the modern prontisol derivatives had somewhat modified his views he still, in the main, held to them. He did not operate on cases where the condition was already obviously on the mend, or on those where the symptoms were slight. In such he waited and observed the course of events. All patients seriously ill, all those who presented a defined tumour and all those in whom the diagnosis was uncertain should be operated on forthwith. He pointed out how easy it was to overlook a small follicular abscess, and as a precaution against such he always stabbed the ovaries in several places. If an abscess was found it should be opened up and left to drain through the tube. He was in favour of drainage in all the cases operated on. In the rare condition of solitary ovarian abscess the infection was staphylococcal, the symptoms severe and the patients were nearly always quite young women.

Pelvic appendicitis was very difficult to diagnose with certainty and every case in which there was the possibility of it should be opened at once. Diverticulitis was very often presented to the gynæcological surgeon. The symptoms were very variable and the diagnosis difficult. It should be remembered that diverticulitis was rare before 50 and salpingitis rare after 50. The best procedure was as a rule colostomy and drainage.

When colic carcinoma perforated, the symptoms often suggested some disaster to the left appendage—all such cases must be operated on at once.

Speaking of the acute abdomen and pregnancy, he said that up to six months the presence of the pregnant uterus made no difference to the treatment but when one of the acute abdominal catastrophes befell a woman at or nearly at full term, the presence of the uterus was a great handicap to diagnosis and treatment. In such he thought that the first step should be to empty the uterus by Cesarean section and then proceed to

**Sections.**—Brain: Showed dead degenerating cysts, the contents of which were necrotic but in some of them the situation of the scolex could be identified. The host capsule consisted of two layers of fibrous tissue, an area of cellular reaction and a zone of limiting gliosis (fig. 1). Muscle: Here the cysts were fusiform owing to the effect of muscle contraction. Sections clearly show the three encapsulating zones.

**Past history.**—Her husband, a soldier, revealed that she went with him to India in 1929 and from there to Burma in 1930. In 1931 she had her first fit, having been perfectly well prior to that date. This was at the age of 31 and two years after her arrival in India. After this attack she had epileptiform fits about every month and they were always worse during her labours subsequent to 1930. Sometimes she became paralysed down one side, sometimes she lost her sight or speech and occasionally her memory failed. For twelve years she had been treated by Army specialists, psychiatrists, physicians and obstetricians but the diagnosis of idiopathic epilepsy was never for one moment in doubt. The X-rays showed how easily the correct diagnosis might have been established had the condition been borne in mind.

**Treatment of cysticercosis cellulosæ.**—No curative medical treatment has yet been discovered. Indeed the indiscriminate use of a parasitocidal substance may aggravate the symptoms by allowing the

## Section of Otology

President—F. C. ORMEROD, F.R.C.S.

[May 7, 1943]

### Some Recent Work on the Investigation and Treatment of "Ménière's" Disease.

By T. E. CAWTHORNE and C. S. HALLPIKE

(From the Research Unit, National Hospital, Queen Square, London).

#### Section I.—Investigation.

By C. S. HALLPIKE

In a certain proportion of patients in whom vertigo occurs in association with deafness, the signs and symptoms are readily recognizable as being due to inflammatory or neoplastic processes involving the labyrinth, the VIIIth nerve or its connexions within the brain-stem.

When these have been excluded there still remains a considerable group long recognized, at any rate in this country, as a well-defined clinical entity and variously referred to as Ménière's syndrome, Ménière's disease, aural vertigo, &c. In these, the vertigo is characteristically paroxysmal, is often associated with nausea, vomiting, deafness and tinnitus, and occurs in the absence of any other neurological abnormalities.

The histological changes in the labyrinth in two cases clinically characteristic of this group were described in 1938 (Hallpike and Cairns). Similar findings were revealed in a third case (Hallpike and Wright, 1939). Since then changes almost identical in character have been described in the affected temporal bones of all of six subjects examined in Witmaack's laboratory by Rollin (1940).

Although certain differences of opinion are likely to continue as to the precise mechanism which underlies the essential feature common to these findings, namely the endolymphatic distension, and relates it to the clinical manifestations, it seems justifiable to regard this work as establishing the morphological basis of this disorder.

The clarification of existing views effected thereby takes two forms: In the first place, it has been shown that gross organic changes occur within the labyrinth and not in the VIIIth nerve, and that in type they conform with startling exactness to the state of endolymphatic hypertension, which had been postulated by Jenkins, Portmann and others.

In the second place, the remarkable uniformity in all of the cases examined of histological changes so peculiar in character suggests that they are due to a specific disease process of the labyrinth, and in this way contradicts a not uncommon but quite opposite view that the disorder could be regarded as a symptom-complex due to a wide variety of pathogenic agents acting within the labyrinth upon the sensory elements, their vascular supply or the labyrinth fluids.

The present paper deals with certain results of investigations of the clinical features of this disorder which have been in progress at the National Hospital for the last two years.

For the greater part the clinical material has been provided from the Out-patients' Department. All the patients suffered from paroxysmal attacks of vertigo, usually associated with deafness and tinnitus. No other neurological abnormalities were present. A blood Wassermann test was carried out in the majority and was negative in all.

#### THE TECHNIQUE, RESULTS AND SIGNIFICANCE OF THE CALORIC TESTS

The tests in question are the caloric tests of Bárány modified in the light of experience and of certain theoretical considerations. The tests are carried out with the patient lying comfortably on a couch, with the head raised 30° from the horizontal. Four tests are carried out, two on each ear, with water at 30° and 44° C. Each ear is irrigated for forty seconds at a constant and fairly free rate of flow. Throughout the tests, the eyes are fixed in the straight ahead position upon a convenient spot on the ceiling. The resultant nystagmus is therefore of the second degree variety and is observed with good illumination from a head mirror at a distance of about 12 in. The measure of the

Two or three cases of carcinoma of the ascending colon with very great distension of the cæcum, in his experience, suddenly gave rise to acute symptoms, and were noticed for the first time when these acute symptoms were present, and then the case was diagnosed as twisted ovarian cyst. These cases, again, might be very difficult, because of course, the twisted ovarian cyst was frequently well up in the abdomen, and not in the pelvis at all. When he suspected that the condition was due to something in the intestinal tract, he had always adopted the principle of calling in a colleague who was experienced in intestinal surgery to deal with them.

On the controversial subject of salpingitis, Mr. Zachary Cope had said that the diagnosis was usually easy because there was a history of infection, there was the gonococcus, and the vaginal discharge; but in his experience patients with acute salpingitis were very often endeavouring to hide gonorrhœa, and did not give a true history.

The onset of salpingitis varied considerably. In a few cases the symptoms appeared suddenly and were acute, but in most cases the onset was insidious and gradual. If the onset was sudden and acute, so that a woman who was going about her daily occupation was suddenly seized with an acute lower abdominal pain, with rise of temperature and tenderness, the differential diagnosis as between acute appendicitis and acute salpingitis was in his experience not nearly as easy as Mr. Zachary Cope had indicated, and in most of these cases with acute onset it was almost impossible to make the diagnosis at all. In such cases the very best treatment was a laparotomy performed at once, within the first twelve or twenty-four hours of the acute onset. The case which gave a history of disease and a gradually increasing pain and discomfort in the lower abdomen would be treated expectantly, and with the sulphonamides; but the sudden acute onset which was seen within twenty-four hours called for immediate laparotomy.

He also wanted to put forward one of the suggestions which he had entertained for many years, namely, that appendicitis in the female was best treated by a mid-line incision. He had seen a good many cases of women who had had lower abdominal pain and had gone to a general surgeon who had made a very small incision, about  $\frac{3}{4}$  in. long, and had taken out an appendix which proved to be pathological only when one measured it with a tape measure, and the same symptoms had continued after the operation. In such cases he had opened up the abdomen and had removed chronic pus tubes which obviously had been there when the appendix was operated upon.

Mr. V. B. Green-Armytage, Mr. Malcolm Donaldson, Mr. K. Vartan and Sir James Walton also spoke.

The President (Dame Louise McIlroy) in summing up said that it was curious that the discussion had turned so largely on the treatment of acute salpingitis. It was often very difficult to diagnose the acute abdomen and she could not understand why the speakers had not laid more stress on the preliminary examination under an anæsthetic. A point on which the late Professor Blair-Bell insisted in a difficult diagnosis was to keep palpating the abdomen while the patient was going under the anæsthetic and to find out in that way the last part of the abdomen to give up its rigidity. The patient resisted to the last moment at the acutely tender portion, and probably the hand would locate where the trouble was.

In acute salpingitis she very seldom opened the abdomen. Tubercular tubes, unless pus was present, she did not as a rule touch. If one interfered by means of surgical treatment in the case of a patient who was tuberculous there was a risk of wakening up an old pulmonary focus. Acute salpingitis was a difficult thing to diagnose, even sometimes under an anæsthetic. At the operation the tubes were removed, as was often the case in years gone by when more radical gynaecology was practised. The patient, usually a young woman, as a consequence was sterilized, and here it was worth while to remember that gynaecological surgeons were halted by a medico-legal or medico-sociological problem which did not affect the general surgeon. The general surgeon could undertake large operations more or less with impunity, but if the ovaries were removed the gynaecological surgeon had to think of possible consequences apart from the immediate welfare of the patient. She herself dilated the cervix and drained the uterus with a self-retaining rubber tube which she thought was the proper way of draining the tubes.

With regard to treatment, more stress should be laid on the method of draining the acute abdomen. She thought it was ideal in a female patient to drain in Douglas's pouch: she put a long curved forceps up in the posterior fornix and cut down on that, putting in gauze or sometimes a drainage tube in the hollow of the sacrum. This was pulled through and left there, later being taken out by degrees or under light anæsthesia. Drainage was thus induced by what she called the natural method. It was a very good method and she could not see why the general surgeon should not adopt it more frequently in preference to putting a drain in the abdominal incision.

directional preponderance? (2) How do the caloric tests reveal it? (3) What is its practical significance when revealed?

(1) Directional preponderance: The phenomenon of directional preponderance of induced vestibular nystagmus was first recognized and described in 1923 by Dusser de Barenne and de Kleyn from the results of certain animal experiments. Working with rabbits, they found that removal of one cerebral hemisphere led to a facilitation of the nystagmic response to any form of vestibular stimulation which produced nystagmus in a particular direction, i.e. with its quick component towards the ablated hemisphere.

Thus, with removal of the right hemisphere, there was an enhancement in the responses of the right ear to hot stimulation and of the left to cold. Similarly, with rotation, there was an enhancement of the response consisting of nystagmus to the right to a cessation of rotation to the left.

An application of these results to the human subject was described by FitzGerald and Hallpike in 1942 who found that directional preponderance did occur in association with some cerebral lesions, but that its occurrence and direction were dependent upon the involvement of one or other of the temporal lobes.

(2) Alterations of caloric responses due to directional preponderance: In fig. 3 at A the normal pattern of the caloric responses is shown again for reference. B shows

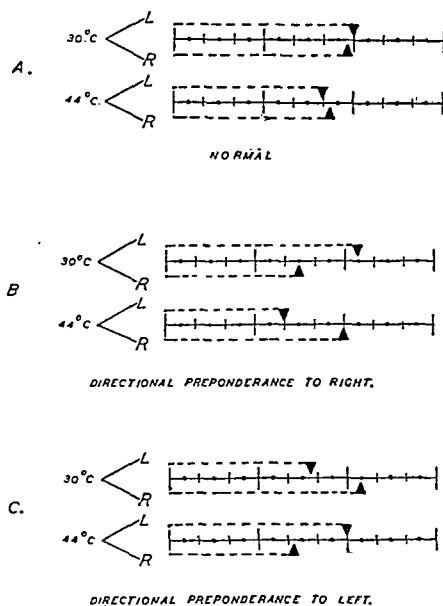


FIG. 3.

directional preponderance to the right resulting from a lesion of the right temporal lobe, i.e. facilitation of the left cold and the right hot responses, both of which consist of nystagmus to the right. With a lesion of the left temporal lobe, there occurs directional preponderance to the left (C), i.e. facilitation of the right cold and the left hot responses, both of which consist of nystagmus to the left.

It is of particular importance to note that of these four reactions, which go to make up the pattern of a directional preponderance, each ear contributes a particular disturbance of its own two reactions. Thus, in the case of directional preponderance to the right, the normal relationship of the cold to the hot reactions of the left ear is altered in favour of the cold, and of the right ear in favour of the hot. It follows that when two of these reactions are eliminated from the pattern, as for example, when one labyrinth is defunct, the presence of a directional preponderance can still be correctly deduced from a characteristic alteration in the responses of the opposite ear. This situation is of importance inasmuch as directional preponderance may arise, as will be seen, as a result of unilateral labyrinth destruction.

The occurrence of directional preponderance in "Ménière's" disease was first recognized



response is taken as the time in seconds between the application of the stimulus and the end of the response. This is conveniently, though inaccurately, described as the response duration. Actually it represents a lumping together of latent period and response duration. For our own purposes, we have not found it an advantage to take special account of the latent period.<sup>1</sup>

The results are expressed in the form which is shown in fig. 1. Each continuous line represents a three-minute period, subdivided into intervals of minutes, twenty seconds

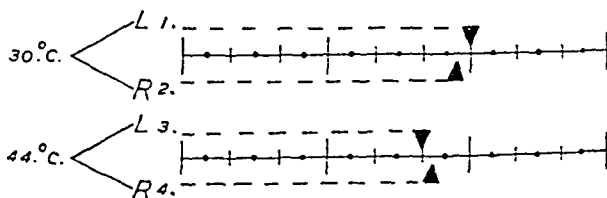


FIG. 1.—Normal.

(Reproduced by permission of the Editor of *Brain*).

and ten seconds. The reactions of the left and right ears are denoted by L. and R., while the stimulus time extends in all over the first forty seconds. The interrupted lines denote the response durations. For further reference the responses are numbered 1-4 from above downwards. In responses 1 and 4 the direction of the nystagmus is of course to the right. In responses 2 and 3 the nystagmus is to the left.

The response pattern shown represents the average normal, with the two cold reactions close together at about two minutes and the two hot reactions also close together and of rather shorter duration. In agreement with all observations since Bárány, we have found that these reactions vary widely in normal individuals. Nevertheless, this variation is chiefly in respect of their general magnitude. The pattern of the responses which determines their diagnostic worth varies much less.

*Principles underlying tests.*—Emphasis is laid upon three points which underlie the rationale of these tests.

(a) *Temperature of the stimuli.*—The organ which is chiefly, and it may be solely, involved is the external canal. For reasons which will be apparent, it is desired that the deflecting powers of the stimuli upon the cupula should be equal and opposite. The temperatures used are therefore 30° and 44° C., 7° below and above body temperature.

(b) *Intensity of the stimuli.*—It is desired that the test should be as sensitive as possible, that is to say, that it should be capable of revealing the smallest significant changes in sensitivity of the cupular end-organs.

Fig. 2 shows the typically sigmoid form of the stimulus intensity-response curve of a number of receptors stimulated together. From this it is clear that for maximum

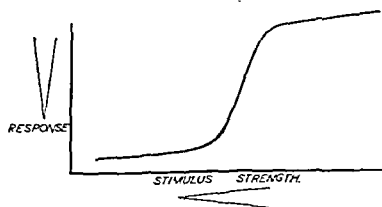


FIG. 2.

sensitivity the stimuli should be of moderate intensity, i.e. that they should fall upon the rising portion of the curve. In the case of the caloric reactions, this condition is fulfilled in the majority of individuals by free irrigation for forty seconds at 30° and 44° C.

(c) *The necessity for using both cold and hot stimulation.*—This is required for the demonstration of the phenomenon originally described as nystagmusbereitschaft and to which we have given the name of directional preponderance (FitzGerald and Hallpike, 1942). To explain this, it will be necessary to answer three questions: (1) What is

<sup>1</sup> For further particulars of the rationale and technique of the caloric tests as modified, reference should be made to *Brain*, 1942, 65, 115.

hot temperatures are selected as being equidistant from body temperature and are therefore calculated to produce equal and opposite effects upon the canal cupula. Now according to Ewald's law, the hot stimulus which causes an ampullo-petal flow of endolymph should give much the bigger response. In fact, however, the cold is the more effective stimulus and our findings over some hundreds of tests show that the cold responses are the greater in the majority of cases. In some, the responses are equal, while in a few the hot responses slightly exceed the cold. The first conclusion, therefore, to be drawn from this diagram is that Ewald's law does not apply to the external canal of the intact human subject. Instead, the canal may be said to exhibit bi-directional sensitivity to endolymph movement.<sup>1</sup>

The second matter to be considered is the behaviour of the reactions of the sound ear, reactions 1 and 3. Before the destruction of the right labyrinth, these two reactions

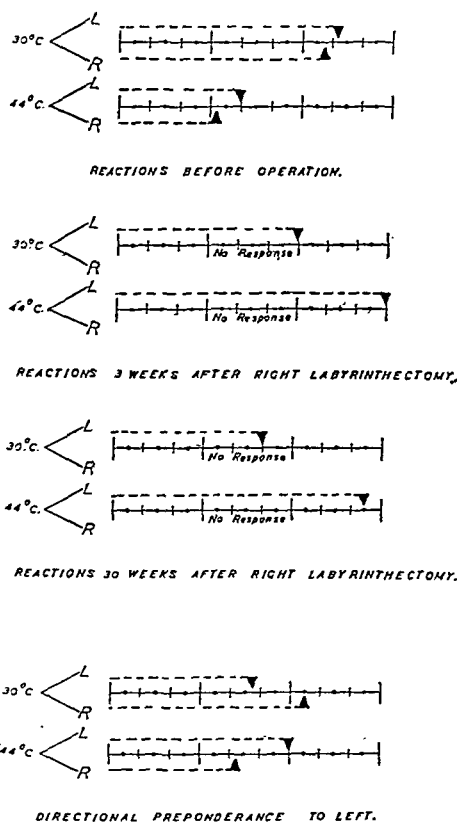


FIG. 5.

exhibit a relationship which is described as normal, with the cold responses exceeding the hot. Three weeks after the operation, however, this relationship is strikingly altered, and the hot response, consisting of nystagmus to the left, is now much larger. Comparison of this with the full pattern of a directional preponderance to the left, shows that while two of the elements have been eliminated by the destruction of the right labyrinth, nevertheless the remaining two reactions of the left ear show the identical disturbance in their relationship which is found here to be characteristic of directional preponderance to the left. In other words, directional preponderance to the left has here been brought about by destruction of the right labyrinth.

If such a patient is examined in a Bárány chair, it will be found, as Bárány found, that there is a marked preponderance of the nystagmic response to the left which occurs

<sup>1</sup> The usual preponderance of the cold response is largely due to the greater fall in the temperature of the hot water in course of its passage to the ear. This renders it physiologically less effective as a caloric stimulus than the cold water.

by Vogel of von Eicken's clinic, who in 1929 gave a very clear account of its occurrence in a number of characteristic cases. Vogel was aware of the work of Dusser de Barenne and de Kleyn upon the effect of cerebral lesions in producing directional preponderance and was led thereby to suggest that his own findings argued in favour of the theory that the lesion in "Ménière's" disease was situated in the central nervous system, and not in the labyrinth.

(3) The mechanism and significance of directional preponderance due to labyrinthine lesions: In this, our own views have been advanced by certain observations upon the effects of unilateral labyrinthectomy carried out for intractable "Ménière's" disease upon the caloric responses of the opposite ear. Present knowledge of the effects of unilateral labyrinth destruction in the human and of their physiological basis is founded upon the work of Bárány. In the great majority of his patients, the destruction was due to suppuration. Following the abatement of spontaneous nystagmus to the opposite side, which is characteristic of the period immediately after the destruction, Bárány found that his patients showed a constant deviation from the normal response to rotation in that there occurred a marked preponderance in the nystagmic response to a cessation of rotation to the side of the affected ear. His findings are illustrated in fig. 4, which shows

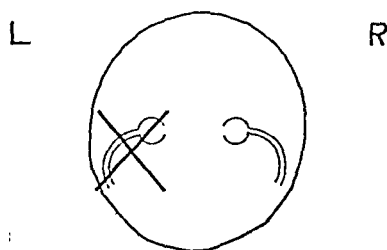


FIG. 4.—Directional preponderance of rotational nystagmus after destruction of left labyrinth. Nystagmus is greater on stopping a steady rotation to the left.

the head with the two horizontal canals from above. The left labyrinth has been destroyed. Rotation now affects the right labyrinth alone. Comparing post-rotational nystagmus to the left and right, Bárány found that much the bigger response, consisting of nystagmus to the right, occurred on stopping a rotation to the left; the ratio of this response to its opposite being characteristically 2:1. According to Ewald's law, the external canal reacts chiefly to ampullo-petal flow of endolymph, and if this law be accepted as valid for the human subject, then according to fig. 4 the right canal, which remains to respond alone, should correspondingly give a bigger response to ampullo-petal flow. Such a flow does result from a cessation of rotation to the left and results in nystagmus to the right. This was exactly what Bárány found and since it was exactly in accordance with Ewald's law, he accordingly regarded this law as confirmed and illustrated by his findings. He also noted that this preponderance in the effect of a rotational stimulation causing an ampullo-petal flow of endolymph became gradually lessened in the course of time. This effect, sometimes known as Rutin's reaction, he attributed to processes of central compensation.

Although Bárány is best known for his work in connexion with the caloric tests, he never established these upon a quantitative basis. On the other hand, he developed very fully the quantitative possibilities of the rotational tests.

Our own approach to the clinical problem of unilateral labyrinth destruction differs from Bárány's in a number of important respects. In the first place, we have made use of the caloric tests both hot and cold, applied in a quantitative manner. In the second place, the labyrinth destruction in our patients was carried out as a surgical procedure as a part of their treatment for "Ménière's" disease. It was therefore possible for us to examine the caloric responses, in particular of the healthy ear, before as well as after labyrinth destruction.

Owing very largely to these differences in the manner of our approach, we have been led to conclusions which differ radically from those of Bárány and for reasons which are contained in fig. 5. This shows the caloric reactions before and after labyrinthectomy of a man who had an eighteen months' history of vertigo and vomiting with increasing deafness of the right ear. Apart from a slight diminution in the responses of the right ear, the caloric responses were normal. The first important feature about this diagram is the greater magnitude of the cold responses. The cold and

hot temperatures are selected as being equidistant from body temperature and are therefore calculated to produce equal and opposite effects upon the canal cupula. Now according to Ewald's law, the hot stimulus which causes an ampullo-petal flow of endolymph should give much the bigger response. In fact, however, the cold is the more effective stimulus and our findings over some hundreds of tests show that the cold responses are the greater in the majority of cases. In some, the responses are equal, while in a few the hot responses slightly exceed the cold. The first conclusion, therefore, to be drawn from this diagram is that Ewald's law does not apply to the external canal of the intact human subject. Instead, the canal may be said to exhibit bi-directional sensitivity to endolymph movement.<sup>1</sup>

The second matter to be considered is the behaviour of the reactions of the sound ear, reactions 1 and 3. Before the destruction of the right labyrinth, these two reactions

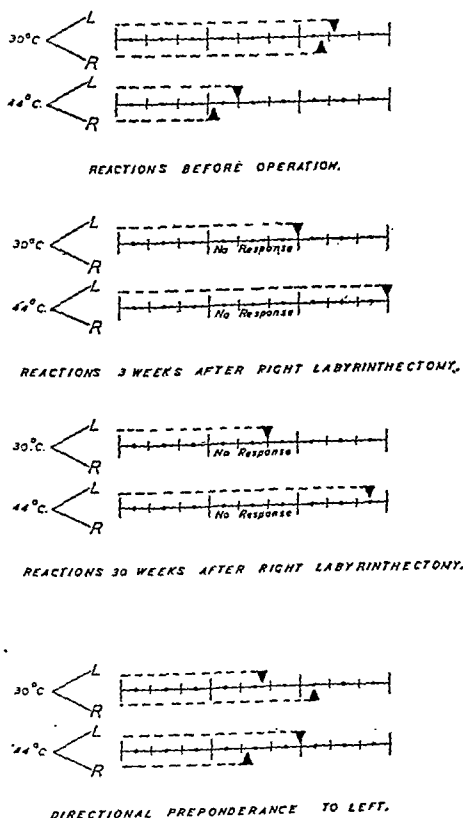


FIG. 5.

exhibit a relationship which is described as normal, with the cold responses exceeding the hot. Three weeks after the operation, however, this relationship is strikingly altered, and the hot response, consisting of nystagmus to the left, is now much larger. Comparison of this with the full pattern of a directional preponderance to the left, shows that while two of the elements have been eliminated by the destruction of the right labyrinth, nevertheless the remaining two reactions of the left ear show the identical disturbance in their relationship which is found here to be characteristic of directional preponderance to the left. In other words, directional preponderance to the left has here been brought about by destruction of the right labyrinth.

If such a patient is examined in a Bárány chair, it will be found, as Bárány found, that there is a marked preponderance of the nystagmic response to the left which occurs

<sup>1</sup> The usual preponderance of the cold response is largely due to the greater fall in the temperature of the hot water in course of its passage to the ear. This renders it physiologically less effective as a caloric stimulus than the cold water.

on stopping a rotation to the right. If further, the hot and cold responses of the left labyrinth continue to be investigated over a period of months, then it will be found, as in this patient, that the preponderance of the hot response gradually disappears. Again a result which is familiar in the form of the so-called Ruttin reaction. Whereas, however, Bárány regarded such a preponderance of the nystagmic response towards the sound ear following destruction of one labyrinth as merely exemplifying and confirming Ewald's law, in other words, that in these circumstances the remaining external canal and its associated central connexions are left alone by a process of simple subtraction to respond in their normal manner, it is clear from these diagrams that the normal responses of the left canal, shown in reactions 1 and 3, themselves contradict Ewald's law and that the directional preponderance which they exhibit after the destruction of the right labyrinth is a pathological state resulting from that operation. Since throughout the left canal itself has remained intact, it follows that these changes in its responses are of central origin. In this way, therefore it becomes possible to say that *directional preponderance in these circumstances is a pathological change in the central responses of the external canal due to destruction of the opposite labyrinth, whether by suppuration or surgical exenteration.*

The establishment of this point is important for two reasons. In the first place, it gives promise that further analysis of the known effects of unilateral labyrinth destruction will lead to an explanation of the underlying mechanism of directional preponderance. In the second place, it makes it possible to regard without surprise, and indeed to anticipate, the occurrence of directional preponderance in the natural course of any disease of the labyrinth involving a loss of its function, in particular, "Ménière's" disease.

Dealing first with the physiological basis of the well-known effects of unilateral destruction of the mammalian labyrinth, both in man and animals, the immediate effects are severe and dramatic. As Magnus showed, these effects are essentially the same whether the labyrinth function is destroyed by surgical exenteration or by cocaineization, and we must therefore agree with him in concluding that they are of paralytic origin. Our present needs will be served by confining ourselves to the consideration of one alone of these effects, namely, spontaneous nystagmus to the opposite side. In man, this usually persists for about a week and is immediately followed, as described, and as we have now observed in all of more than a dozen cases, by a directional preponderance of caloric or rotational nystagmus in the same direction. The correspondence in direction and the unbroken transition between the original spontaneous nystagmus and the directional preponderance which succeeds it, make it extremely probable that the latter is a residuum of the former and that both should, therefore, be explicable upon the same basis.

*The physiological basis of spontaneous nystagmus following unilateral labyrinth destruction.*—Fig. 6 shows in diagram form certain principles governing the vestibular

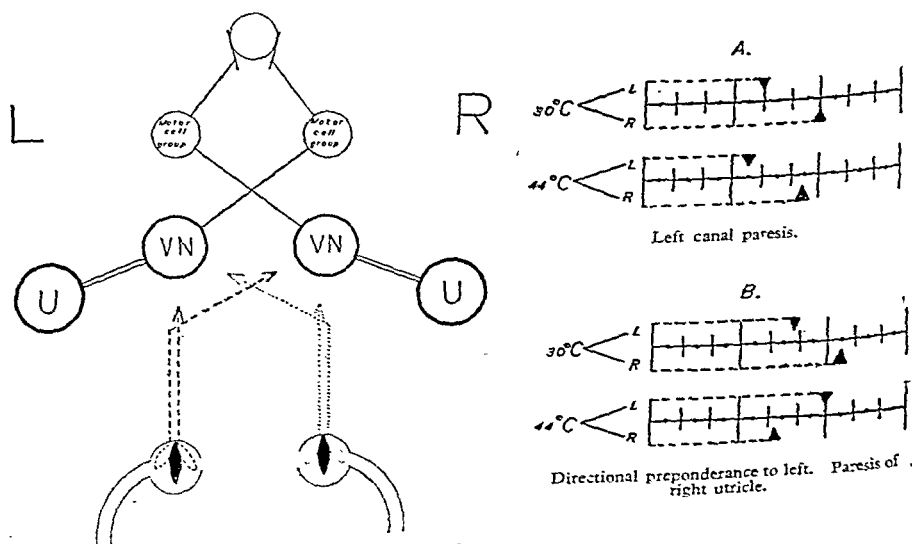


FIG. 6.

control of human eye movements in the horizontal plane, which it is reasonable to accept as established. For the purpose of simplicity, the two eyes are replaced by one which is moved by two sets of muscles, its left and right turners, each activated by its particular set of motor cells, labelled as motor cell groups.

Nystagmus is a compound ocular movement of which the slow deviation is the primary element and is usually initiated from the periphery. The quick component follows the slow and is initiated by it through a reflex mechanism subserved by certain subsidiary cell groups, which according to Lorenté de Nô are located within the *substantia reticularis*. For the present purpose, the slow deviation is the primary element and it is the slow deviation which has been made the basis of the diagram (fig. 6). The impulses which reach the motor cell groups from the labyrinths are of two kinds. There are firstly the tonic impulses, represented by continuous lines. The bulk of the evidence at present available favours the view that these tonic impulses are derived principally from the utricle.

Considering first the effects of interrupting all impulses passing up the right VIIIth nerve by destruction of the labyrinth on this side, the immediate result is nystagmus to the opposite side, involving that is to say a primary ocular deviation to the same side. The condition is paralytic in nature and is, therefore, due to the elimination of impulses reaching the vestibular nuclei from the affected labyrinth. Since also the nystagmus is continuous at rest, the impulses concerned must be of the tonic class and must, therefore, be chiefly of utricular origin.

It is argued, therefore, that the spontaneous nystagmus which immediately follows destruction of one labyrinth is due to the elimination of tonic impulses from the affected utricle. As is known also, this spontaneous nystagmus ceases to be manifest after some days<sup>1</sup> and is followed by a period of latency. In the course of this period, the effects of any stimulus applied to the opposite labyrinth which again evokes this nystagmus will be strongly facilitated. This stage corresponds to the directional preponderance of caloric or rotational nystagmus, which has already been described and which later tends to disappear.

If, as seems likely, directional preponderance is a diminishing form of the spontaneous nystagmus which immediately follows destruction of one labyrinth, then it follows that directional preponderance itself must also be attributed to the elimination of utricular impulses from the affected labyrinth.

The anticipated pattern of the caloric responses resulting from a right utricular lesion is shown at B in fig. 6. There is a facilitation of responses 2 and 3, the right cold and left hot, in which the primary deviation is to the side of the affected utricle, the right, with nystagmus of course to the left. Quite apart from such tonic impulses, ocular deviations are usually initiated by phasic responses of the canal organs to rotational or caloric stimulation. These impulses are represented in fig. 6 by interrupted lines. An ampullo-petal flow of endolymph in the right canal is caused by hot caloric stimulation. This results in a transient reinforcement of the tonic impulses leaving the right vestibular nuclei and induces an ocular deviation to the left, i.e. nystagmus to the right. The same result is achieved by an ampullo-fugal movement of endolymph, which would result from cold stimulation of the left canal. Conversely, the left vestibular nuclei receive phasic reinforcements in the same manner from ampullo-fugal flow in the right and ampullo-petal flow in the left canals, induced respectively by hot and cold stimulation. In both cases, the result is ocular deviation to the right, i.e. nystagmus to the left.

These considerations lead to the expectation that a quite different type of disturbance in the normal pattern of the caloric responses would be likely to result from the selective destruction, partial or complete, of an external canal crista such as might also be expected to occur in the course of a labyrinthine disease, such as "Ménière's" disease. The pattern of the caloric responses in such a lesion of the left canal is shown at A in fig. 6. Under these conditions, there is neither spontaneous nystagmus nor any directional preponderance. Instead, the cold and hot responses of the left canal are equally reduced. Meanwhile, the two responses of the opposite canal exhibit their normal relationship, so showing the absence of directional preponderance.

Two quite distinct varieties of change in the normal pattern of the caloric responses have now been described, directional preponderance and canal paresis. On hypothetical grounds these have been attributed respectively to lesions of the utricle and external canal. We are led now to consider whether in fact such changes have been encountered in our own series of cases and, if so, to what extent.

<sup>1</sup> For a discussion of the probable neural mechanism which is responsible for the disappearance of the spontaneous nystagmus, see Brain, 1942, 65, 151.

Table I gives the results of the caloric tests in 100 cases of "Ménière's" disease seen at Queen Square. Of these 12 gave normal reactions. In 21 there was a directional preponderance and in 49 a canal hypofunction.

TABLE I.—HALLPIKE AND CAWTHORNE—100 CASES.

	Normal	Directional preponderance	Canal paresis	Directional preponderance with canal paresis
1st 50 cases ...	6%	20%	58%	16%
2nd 50 cases ...	18%	22%	40%	20%
Total 100 cases	12%	21%	49%	18%

TABLE II.—DE KLEYN AND VERSTEEGH—100 CASES.

Normal	Nystagmus-bereitschaft	Unequal sensitivity of the two labyrinths
16%	11%	73%

It has been of the greatest interest to compare these results with results described by de Kleyn and Versteegh in an important paper to which our attention has recently been directed, published in 1933. Their results are also shown in Table II. They agree with Vogel in finding directional preponderance, but in addition they find many cases in which the caloric tests gave results corresponding to our own group of canal hypofunction. The technique of stimulation which they used was Kobrak's, using both cold and hot water and, if account be taken of the difference in the two methods of testing, the two sets of results show a fair measure of agreement.

De Kleyn and Versteegh do not attempt to explain the mechanism of these abnormalities and indeed express their acceptance of the vascular spasm theory as the pathological basis of the disorder. This consideration is, however, of less concern than the fact that these particular abnormalities in the caloric reactions do occur, and in this respect, our own agreement with the earlier findings of de Kleyn and Versteegh, arrived at quite independently, is worthy of considerable emphasis.

In addition to these two types of change, certain others have been encountered. These occur quite frequently and their nature and significance were for some time obscure. One such change is shown in fig. 7. While the two cold responses are approximately equal, there is a gross inequality in the hot responses. A change of this kind, when it occurs, is usually associated with deafness in the left ear and is therefore likely to be due to disease of the left labyrinth. This being so, it has seemed reasonable to suggest that it might be due to lesions of the left canal and utricle occurring in combination.

How these lesions may combine to produce the result is shown in fig. 7. B is the pattern of a left canal lesion; C the pattern of a left utricular lesion with directional

Combined lesions of left external canal and left utricle.

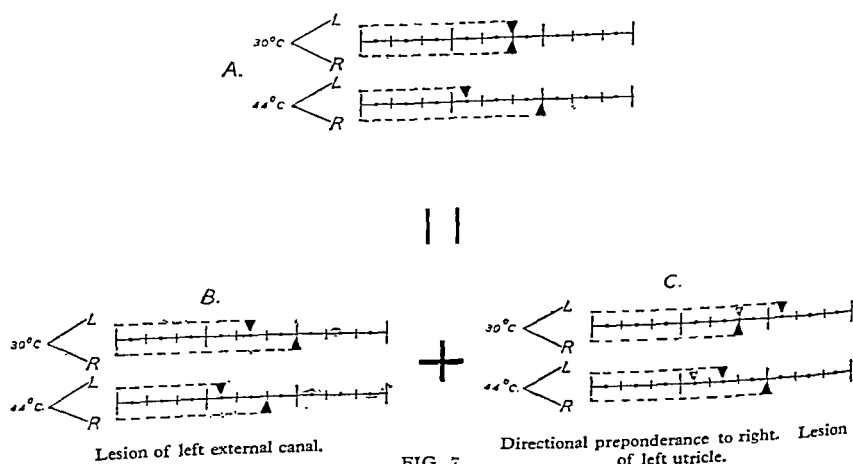


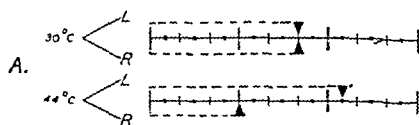
FIG. 7.

preponderance to the right. B is combined with C by shortening reactions 1 and 3 in C. The result reproduces the original pattern A.

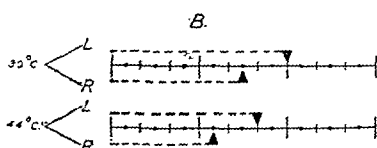
Another variety of irregularity, produced probably in a similar way, is met with nearly always in association with a deafness of the right ear. Its pattern is shown in

fig. 8. The two cold reactions are again close together, while once more the hot reactions diverge widely. In this case, however, the direction of the divergence is opposed to that seen in fig. 7A, in which the right exceeded the left. Here the left

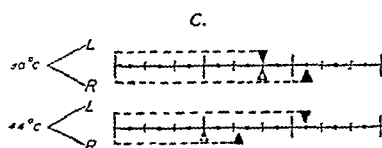
Combined lesions of right external canal and right utricle.



||



Lesion of right external canal.



Directional preponderance to left. Lesion of right utricle.

FIG. 8.

exceeds the right. B is the pattern of a right canal lesion and C is the pattern of a right utricular lesion with directional preponderance to the left. B is combined with C by shortening reactions 2 and 4 in C. The result reproduces the original pattern A.

Referring again to the table, we see that of 100 cases, reactions of this kind were encountered in 18.

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## Section II.—Treatment

By T. E. CAWTHORNE

ALTHOUGH "Ménière's" disease does not cause any obvious pathological changes in the body apart from the labyrinth it can, by the very violence of its symptoms, reduce the sufferer to a state of chronic invalidism. Thus it requires a person of robust temperament to bear with equanimity the disturbance both mental and physical that forms part of the recurrent attacks. Those who are unable to stand up to the ordeal will exhibit symptoms of nervous strain in varying degree. Such patients do not always respond easily to treatment because even if they are relieved of their severe attacks they may find difficulty in regaining self-confidence. They require constant encouragement and careful rehabilitation, particularly if they have been submitted to operation. Another factor to be considered, especially when any particular form of treatment is being assessed, is the natural tendency of the disease towards spontaneous remissions, and it is important to guard against attributing such a remission to a successful response to treatment.

Before describing in detail two forms of treatment that have been found helpful a short review will be given of some of the more generally accepted measures for the alleviation and treatment of "Ménière's" disease.

Sedatives have long been in use and of these phenobarbital has established itself as the most popular, and rightly so, for regular doses of this drug seem to discourage the spread of the disturbance caused by an attack to other parts of the central nervous system.

That overloading of the affected labyrinth with fluid played a part in causing the



symptoms may have been suspected by Politzer (1893) when he advocated pilocarpine. This theme was elaborated by Dederding (1929) who postulated a general condition of fluid retention due to abnormal water metabolism for which she advised diuretics and a reduced fluid intake. Furstenberg, Lashmet and Lathrop (1934) carried this a step further and described a regime that favoured excretion of the fluid-binding sodium. These measures have been employed often with good results in cases where the strict dietetic regime is and can be faithfully followed.

Recently Sheldon and Horton (1940) have reported on the value of histamine in a certain proportion of cases and this has been confirmed by others, although no one is quite clear why this should be. In the small number of cases in which we have used histamine about one-third have been helped.

It has been suggested by Atkinson (1942) that a favourable response to histamine treatment can be expected in allergic cases that give a positive skin reaction to histamine, but it is not certain how much reliance can be placed on such a skin test.

Nicotinic acid has been advocated by Atkinson (1942) for its vasodilatation effect. We have no experience of this form of treatment.

Inflation of the Eustachian tube has been practised extensively although opinion differs as to the number of cases of "Ménière's" disease that are associated with Eustachian insufficiency. We very rarely see it, and we do not think that the false negative Rinne that is so often noted in unilateral perception deafness in any way indicates a lesion in the conducting part of the auditory mechanism.

Wright (1938a) has found that relief from attacks can be expected when a focus of sepsis is found and eradicated. We have examined all our cases for evidence of oronasal sepsis and have taken suitable steps to remove any that has been found, with improvement in some cases. The proportion of such cases has, however, been small and it would seem doubtful whether infection in the nose or throat plays a very important part in the causation of the disease.

Of the operative measures employed the most rational would seem to be drainage of the saccus endolymphaticus as advocated by Portmann (1927). Woodman and Adams (1939) have also described several cases in which this has been done. We have attempted this operation in two cases. In one, the saccus was opened, but the other presented difficulties that made it impossible to be sure that the saccus had been opened. In the first there was a gradual loss of activity, leading slowly to complete extinction of function. In the second there was but little post-operative disturbance and no loss of function. Drainage of the perilymph space was advocated by Hautant and others and Mollison (1935) and Mill (1936) have each reported series of cases in which alcohol was injected into the labyrinth after opening the perilymph space of the external semicircular canal, thereby destroying all function. After the initial post-operative disturbance was overcome this procedure resulted in the abolition of paroxysmal attacks. The cases that we have treated in this manner have resulted in complete absence of response to both cochlear and vestibular stimulation.

Section of all or part of the VIIIth nerve has long been in favour, especially in America where Dandy (1928), and in France where Aubry and Ombredanne (1937), have reported large series of cases. In this country Cairns and Brain (1933) have also reported good results. Recently all these workers have contented themselves with section of the vestibular division of the VIIIth nerve only, leaving the cochlear division intact, so that what remains of the hearing will not be disturbed. In this connexion it may be mentioned that the disease may cause such distortion of hearing on the affected side that any but the softest of sounds are distressing, and several of our patients have volunteered the information that the loss of distorted hearing on the diseased side has enabled them to listen to loud sounds such as the wireless and children's voices without discomfort.

Wright (1938b) injects alcohol into the perilymph space through the tympanic membrane and stapes footplate. This gives the same results as the other forms of alcohol injection and it has the great merit of being surgically simple.

There are two variations of the forms of treatment mentioned that we have found helpful. We have been using a combination of hyoscine gr. 1/600, hyoscyamine gr. 1/150 that is the basis of a well-known and I am told effective sea-sick remedy known under the proprietary name of "Vasano". One to three of these tablets a day is often sufficient to keep the attacks at bay, but excessive dryness of the throat or transitory blurring of vision may call for a smaller dosage or changing over to a mixture of luminal gr. ½ and pilocarpine gr. 1/12 to be taken two or three times daily.

If this or a combination of the other conservative measures already mentioned does not keep the symptoms in check, then the possibility of destruction of function is considered. We do not favour the operation that is to be described unless the disease

cannot be checked by conservative treatment and unless there is a considerable loss of hearing on one side and good hearing on the other. Of the cases under review 20% have been submitted to operation and as a number of other cases have been seen during this period that have not been included it is probable that less than 15% of all cases seen have been operated on.

We have found that in order to abolish function in the labyrinth all that is necessary is to open the endolymphatic space. We have found that the injection of alcohol is not essential as the same results can be produced by merely opening the membranous labyrinth. In order to ensure that the endolymphatic space is properly opened we now remove a portion of the membranous labyrinth from the external canal, this part of the labyrinth being chosen as being the most accessible.

In order to do this it is necessary to work in a magnified field and for this we have since 1938 been using a Leitz binocular dissecting microscope giving 10 diameters of magnification. We have tried with 5 and with 20 diameters, but have found that the 10 diameter magnification is the most convenient. This particular dissecting microscope has the great advantage of having a working distance of 22 cm. between the microscope and the object, thus enabling the operation to be carried out without transgressing the aseptic ritual. Such an instrument has been in use for many years in animal otological surgery. Holmgren (1923) was the first to use a binocular dissecting microscope for operations on the labyrinth. Tullio of Parma (1938) described its use in mastoid surgery, and more recently Shambaugh (1942) in America has used it in the surgical treatment of otosclerosis. We have found the microscope to be of very great help in many operations on the temporal bone, particularly in those on the facial nerve (Cavathorne, 1941) and the internal ear.

The approach to the labyrinth is via the mastoid, sufficient bone being removed to ensure a good view of the external semicircular canal. This calls for enlargement of the aditus and removal of the incus. Care is taken not to encroach upon the osseous meatal wall for fear of opening into the external meatus, because it is felt that such an incident may prejudice healing by first intention. In the case of a cellular mastoid no attempt is made to open up all the cells or indeed any more than are necessary to obtain a proper exposure of the canal. For this part of the operation it is neither necessary nor is it particularly convenient to use the microscope. When the canal has been adequately exposed, especially in the antero-inferior aspect of its convexity, the bone in this region is carefully and slowly removed with a dental burr under the microscope. We have found that a diamond dust burr is easier to work with than the ordinary steel burr because it does not get clogged with bone dust, it remains sharp indefinitely, it has a very gentle bite and it is less inclined to slip or run. We use a portable dental machine working at 3,000 revolutions per minute. Working the drill along the convexity of the external canal in its lower half, backwards and forwards through an excursion of about 5 mm. a trough is gradually excavated. As the lumen of the canal is approached it will be possible to see a dark tache in the trough which marks the line of the lumen. This is followed forwards and backwards so that from 5 to 10 mm. of lumen will be exposed. As soon as the lumen is opened perilymph seeps through and converts the dry bone dust into a soggy mass like wet sugar. The remainder of the exposure is then carried out with sharp dental instruments, and when the debris has been cleared away the transparent membranous canal will be seen in the upper part of the lumen like a fine glass tube. This is seized with fine forceps and removed, a procedure that sometimes is tedious, as the membranous tube may be elusive. Once this has been removed the operation is ended and the mastoid wound stitched up without drainage. So far 52 cases have been operated on, of which 20 occur within the present series of 100 cases under review. All have healed by first intention and there have been no complications. The immediate post-operative effect has been the same as in other forms of labyrinth destruction and the degree of post-operative disturbance has been largely governed by the amount of function that was present in the affected labyrinth before operation. Where there has been but little function beforehand, and I refer of course to the vestibular part, there is likely to be but little disturbance afterwards, and conversely where the response to the caloric test has been active, the post-operative disturbance will be much more marked. In this connexion it may be mentioned that marked pre-operative impairment of function is the probable explanation of the observations of Dandy (1928) and Symonds (1933) that section of the VIIIth nerve causes but little disturbance; we cannot think of any grounds for believing that section of the nerve will cause less disturbance than destruction of the end-organ. It is not necessary to describe in detail the nature of the post-operative disturbance; the typical picture of acute vestibular failure with the patient lying usually on his sound side, his head almost pushed into the pillow for support against the vetigo, a vomit bowl at hand

and the eyes closed. He dislikes any movement and if he opens his eyes he will be found to have an obvious nystagmus, even when looking in the direction of the slow component. In fact it is not easy to get him to look in any other direction. This will be the picture if there was a fairly active labyrinth before operation. Fortunately many of the patients submitting to operation have but little vestibular function on the affected side and the post-operative reactions are proportionately less severe. It is not uncommon when there is but little pre-operative function to find the patient lying on his back propped up with pillows and reading the paper the day after the operation. We have found that the younger patients of both sexes tend to suffer from difficulty in micturition for the first two days after operation and in six cases administration of doryl or catheterization was necessary. In only two cases has there been any evidence of function after the operation, either cochlear or vestibular. Both of these were cases in which an attempt was made to drain the saccus. In the first, function slowly faded away until the labyrinth was dead and in the second, in which there was some doubt as to whether the operation had been properly carried out, function remained. The following tables have been drawn up to show the effect of the operations on the principal symptoms.

TABLE I.

		Sex		Age		Duration of symptoms	
		Male	Female	Under 40	Over 40	Under 2 years	Over 2 years
Improved ...	...	29	19	15	33	19	29
Not improved	...	4	—	1	3	2	2
Total	...	33	19	16	36	21	31

TABLE II.

Operation	Vertigo			Tinnitus			Hearing		
	Improved	Not improved	No record	Improved	Not improved	No record	Improved	Not improved	No record
A. Canal opened (8)	7	1	—	4	3	1	2	5	1
B. Canal excised (32)	31	1	—	16	14	2	9	21	2
C. A or B plus alcohol (10)	8	2	—	2	7	1	—	10	—
D. Saccus incised (2)	2	—	—	1	1	—	—	2	—

As regards the final result, there have been two cases in which after a period of two years in one case and eighteen months in the other the symptoms returned, only this time the vertigo was in a different direction and the other ear was obviously affected. In another case after a clear interval of some six months the same symptoms returned, whilst in a fourth case the symptoms were unaffected by the operation. The rate of recovery from the post-operative disturbance depends not only upon the degree of pre-operative function but also in no small measure on the temperament and outlook of the patient. The patient of equable temperament who is eager to return to normal life will welcome the relief from attacks afforded by the operation and is unlikely to have much difficulty in readjusting himself to having to go about his work with only one labyrinth. Many patients suffering from "Ménière's" disease are, however, profoundly disturbed by their attacks and may become unduly apprehensive about the possibility of future attacks. Such patients may find it difficult to reorientate themselves after operation, especially as they find that being deprived of a labyrinth, even though it functions intermittently like a spluttering engine, means that they will be liable to momentary unsteadiness after sudden head movements. Patients who have been profoundly upset in the past by their attacks may find it difficult to adjust themselves even to this momentary unsteadiness and it may take some time before they can gain confidence and be reassured that these fleeting symptoms do not mean more attacks and that they need not limit their activities. Recently it has been found most advantageous to encourage rehabilitation by means of special exercises that have been devised at the Rehabilitation Centre at the Horton Emergency Hospital under the care of Dr. Cooksey. These exercises include head and eye movements, walking up and down stairs, bending and stooping and walking with the eyes closed. They are designed to encourage the patient to adjust himself to any unsteadiness that follows such movements. We believe that these exercises, originally devised for soldiers suffering from post-concussional vertigo, will be of the greatest value in hastening and perfecting the process of readjustment. Generally speaking we find that an average case can return to his former employment after two months. Two recent patients who had but little pre-operative labyrinthine function insisted on returning to their duties, one as a clerk, the other as a male nurse, within a month of operation, but such rapid recoveries are unusual. Some take much longer and a few are unable to work again, although they no longer have attacks (Table III).

In conclusion, we have not found any one form of conservative treatment that we

TABLE III.

No.	Name	Date	Sex	Age	Side	Duration years	Operation	In Hosp. days	Post Op. Function	Vertigo	Tinnitus	Hearing	General State	At Work
1	E. J.	21.2.38	F.	47	L.	2	Canal opened.	43	0	Slight constant	Worse	Better	Improved	Light Household
2	D. D.	30.3.38	M.	27	L.	24	Canal opened.	21	0	Better	Worse	Worse	Improved	No
3	F. H.	3.8.38	F.	35	R.	4	Canal opened.	16	0	Abolished	No record	Unchanged	Improved	No
4	A. S.	11.8.38	F.	40	R.	4	Canal opened.	18	0	Returned after 0/12. Not so bad	Unchanged	Unchanged	Improved	Formerly bedridden up and about
5	L. C.	13.8.38	F.	40	R.	5	Canal opened.	15	0	Slight	Improved	Unchanged	Improved	Yes, After 2/12
6	G. R.	27.10.38	F.	40	R.	7	Canal opened.	15	0	Slight when tired	Improved	Unchanged	Improved	Yes
7	M. H.	6.11.38	F.	30	R.	7	Canal opened.	18	0	Abolished	Improved	Not noted	Improved	Yes
8	H. P.	9.11.38	F.	49	R.	2	Canal opened.	10	0	Abolished	Unchanged	Better	Improved	Yes
9	H. P.	30.11.38	F.	67	L.	4	Canal opened.	10	0	Slight	Abolished	Unchanged	Improved	Yes after 5/12
10	S. L.	18.1.39	F.	59	L.	1	Canal excised.	11	0	Abolished	Abolished	Better	Improved	Yes
11	S. D.	20.3.39	M.	42	R.	1	Canal excised.	41	0	Abolished	Abolished	Better	Improved	No
12	A. B.	12.4.39	F.	56	R.	2	Canal excised.	11	0	Slight when tired	Improved	Unchanged	Worse	Yes
13	H. K.	7.1.40	M.	53	R.	6	Canal excised.	31	0	Better 2 years. Returned	Worse	Worse	Improved	Yes
14	R. H.	20.1.39	F.	47	L.	20	Canal excised.	24	0	Slight when tired	Unchanged	Unchanged	Improved	Yes after 2/12
15	E. K.	21.1.39	M.	45	R.	5	Canal excised.	13	0	Abolished	Improved	Better	Improved	Yes after 14/12
16	E. K.	11.5.39	M.	35	L.	14	Canal excised.	8	0	Abolished	Unchanged	Unchanged	Improved	Yes
17	A. D.	21.5.39	F.	48	L.	4	Canal excised.	10	0	Abolished	Improved	Unchanged	Improved	Yes after 6/12
18	A. D.	21.5.39	F.	48	L.	3	Canal excised.	22	0	Abolished	Improved	Unchanged	Improved	Yes
19	E. K.	18.1.40	F.	63	L.	7	Canal excised.	18	0	Slight on movement	Unchanged	Unchanged	Improved	Yes
20	E. K.	21.1.40	F.	63	L.	6	Canal excised.	20	0	No record	No record	No record	Improved	Yes limited after 18/12
21	M. M.	1.5.40	F.	43	L.	3	Canal excised.	23	0	No record	No record	No record	Improved	Yes
22	W. C.	21.9.40	F.	27	L.	3	Canal excised.	10	0	Slight when noisy	Improved	Unchanged	Improved	Yes after 10/52
23	W. C.	2.8.40	M.	42	R.	4	Canal excised.	18	0	Slight. Momentary for 1 year	Improved	Better	Improved	Yes after 1/12
24	E. M.	19.10.40	M.	31	L.	4	Canal excised.	18	0	Momentary	Improved	Better	Improved	Yes after 10/52
25	D. K.	21.10.40	M.	18	R.	4	Canal excised.	16	0	Abolished	Unchanged	Unchanged	Improved	Yes after 2/12
26	W. S.	4.11.40	M.	53	R.	2	Canal excised.	24	0	Abolished	Unchanged	Unchanged	Improved	Yes after 2/12
27	E. P.	4.12.40	M.	43	R.	2	Canal excised.	19	0	Slight	Unchanged	Occasionally distorted	Improved	Yes after 18/12
28	V. T.	14.12.40	M.	43	L.	5	Canal excised.	19	0	Slight occasional	Unchanged	Unchanged	Improved	Yes
29	H. L.	20.3.41	F.	51	L.	2	Canal excised.	21	0	Slight occasionally	Improved	Better	Improved	Yes
30	H. L.	2.4.41	F.	45	L.	1	Canal excised.	52	0	Slight occasionally	Unchanged	Unchanged	Improved	Yes after 6/52
31	H. L.	2.4.41	F.	45	L.	1	Canal excised.	7	0	Very slight occasionally	Unchanged	Unchanged	Improved	Yes after 6/52
32	H. L.	2.4.41	F.	45	L.	1	Canal excised.	31	0	Abolished	Unchanged	Better	Improved	Yes after 7/52
33	G. A.	4.9.41	M.	38	R.	4	Canal excised.	14	0	Abolished	Unchanged	Better	Improved	Yes after 6/12
34	G. A.	17.9.41	M.	38	R.	4	Canal excised.	50	0	Frequent	Unchanged	Unchanged	Improved	Yes after 9/12
35	E. T.	22.10.41	F.	32	R.	1	Canal excised.	13	0	Slight. Frequent	Unchanged	Unchanged	Improved	Yes after 2/12
36	E. T.	5.11.41	F.	32	R.	2	Canal excised.	13	0	Slight occasionally	Unchanged	Unchanged	Improved	Yes after 6/12
37	R. C.	12.11.41	F.	57	L.	1	Canal excised.	10	0	Abolished	Unchanged	Unchanged	Improved	Yes after 6/12
38	A. T.	19.11.41	M.	41	L.	4	Saccul incised.	10	0	Slight constant	Unchanged	Unchanged	Improved	Yes after 4/12
39	W. L.	12.12.41	M.	56	L.	1	Canal excised.	92	0	Slight on movement	Improved	Unchanged	Improved	Yes after 4/12
40	E. McC.	17.12.41	M.	59	R.	1	Canal excised.	10	0	Slight occasionally	Unchanged	Unchanged	Improved	Yes after 2/12
41	H. P.	28.1.42	M.	52	R.	1	Canal excised.	13	0	Abolished	Unchanged	Unchanged	Unchanged	No
42	R. F.	25.2.42	M.	54	R.	3	Attempted saccul incision.	10	Not abolished	Unchanged	Improved	Worse	Unchanged	Yes after 5/12
43	F. D.	4.3.42	M.	25	R.	3	Attempted saccul incision.	10	Not abolished	Slight on movement	Improved	Unchanged	Improved	Yes after 5/12
44	M. B.	18.2.42	F.	46	L.	3	Canal excised.	23	0	Abolished	Abolished	Unchanged	Improved	Yes after 0/52
45	C. F.	18.2.42	F.	46	L.	3	Canal excised.	17	0	Abolished	No record	Unchanged	Improved	Yes after 3/12
46	F. H.	6.12	M.	37	R.	1	Canal excised.	29	0	Slight occasionally	Unchanged	Unchanged	Improved	No
47	F. H.	30.9.42	M.	61	L.	1	Canal excised.	31	0	Slight constant	Unchanged	Unchanged	Improved	Yes after 2/12
48	P. W.	14.10.42	M.	37	L.	2	Canal excised.	27	0	Slight occasional	Unchanged	Unchanged	Improved	Yes after 10/52
49	A. B.	25.11.42	M.	53	R.	1	Canal excised.	16	0	Abolished	Improved	Unchanged	Improved	Yes after 1/12
50	A. B.	20.1.43	M.	60	R.	1	Canal excised.	23	0	Abolished	Improved	Unchanged	Improved	Not yet
51	A. C.	7.1.43	M.	59	R.	1	Canal excised.	14	0	Abolished	Improved	Unchanged	Improved	Not yet
52	P. C.	21.4.43	F.	38	L.	3	Canal excised.	30	0	Abolished	Improved	Unchanged	Improved	Not yet

have mentioned give uniform results in every case and we think that it may often be desirable to combine or alternate the various measures available.

As regards operative treatment, we have found that opening the endolymphatic space in the manner described is sufficient to abolish function in the labyrinth and that this procedure is quite safe and is not followed by any untoward results.

We recommend it for those cases of "Ménière's" disease with marked deafness or distortion on the affected side which do not respond to some form of conservative treatment.

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**Mr. A. J. Wright:** The deafness of "Ménière's" disease.—In order to gain a broad picture of the degree of deafness met with in this disease I made an analysis of the records of 100 cases.

The degree of hearing is described under the terms good, useful and bad. By good hearing is meant perception for the whispered voice at 15 feet; useful hearing, perception for the conversation voice at 6 feet or more; bad hearing, no perception for the conversation voice at 6 feet.

It was surprising to find on taking the group of 100 cases as a whole that in only 8 of them was the hearing bad in both ears. Of the remainder 41 retained good hearing in one ear, 7 good hearing in both, and the remaining 44 retained useful hearing in at any rate 1 ear.

Of the cases with good hearing in both ears at the time of examination the complaint had existed for periods of three months, four months, two, three, four, fifteen and nineteen years respectively.

It would therefore seem that this disease only produces a high-grade hearing defect in about 8% of cases while about a similar proportion may be expected to retain good hearing in both ears over long periods. Of the remainder about an equal number may be expected to retain good or useful hearing in at any rate one ear.

From this analysis cases would seem to fall into two groups, those with a unilateral and those with a bilateral onset. In this series 72 were of unilateral onset and 28 of bilateral. The smaller group seems to present certain special features. Thus the outlook from a hearing point of view seems to be relatively bad, seven of the total of eight cases recorded as bad occurring in this group. In addition these bilateral cases seem to be most resistant to treatment. In two of them in which the C.S.F. was investigated an increase in protein content was observed. This finding would perhaps suggest an associated derangement of perilymph, endolymph and C.S.F.

From the point of view of employment of any destructive operation for the relief of the vertigo, it is of importance to estimate the probability of a serious degree of loss of hearing taking place in the future in the unoperated ear.

I found that of the 72 cases with a unilateral onset in only 13 did the other ear become affected later. The longest interval preceding this involvement was twenty-five years, the shortest eight months, and in 9 of the 13 cases the period was greater than ten years. Actually only 1 of these 13 cases did not retain useful hearing. Thus the chance of an individual retaining good hearing over a long period in a case of unilateral onset would seem to be good.

From a clinical standpoint, therefore, "Ménière's" disease does not frequently produce a high grade deafness in both ears; when it does so it is usually in cases in which the complaint is definitely bilateral in onset; where the complaint is decidedly unilateral there is a strong probability that the other ear will retain useful hearing in the future.

**Major T. A. Clarke:** Observations on the caloric tests of vestibular function.—In September 1942 Cawthorne, FitzGerald, and Hallpike published three papers under the general title "Studies in Human Vestibular Function". It is with certain theses therein contained that this paper is concerned.

*Labyrinthine tonus.*—Cawthorne, FitzGerald and Hallpike put forward the hypothesis that the utricle is the seat of origin of the continued labyrinthine tonus, the interruption of which, e.g. by labyrinthectomy, or the diminution of which in disease, is responsible for spontaneous nystagmus or the phenomenon of directional preponderance of nystagmus to which they draw attention.

It would seem that their argument is based upon Ross's investigation of action currents

in the VIIIth nerve of the frog, recording that certain parts of the nerve, inactive during rest, were active during rotation; and also based (perhaps fundamentally) upon McNally and Tai's experiments also upon the frog, finding that ablation of nerve impulses from all the labyrinthine parts except the utricle produced no change of posture, whereas ablation of the utricle produced gross change of posture.

Cawthorne, FitzGerald and Hallpike themselves draw attention to the danger of making assumptions as to human vestibular function from findings in one or another animal—notably for example in the case of the pigeon (Ewald's pneumatic hammer experiments), the frog (unidirectional sensitivity of the canals to endolymph flow), and the dogfish (Löwenstein and Sand's finding of tonic impulses proceeding from the canals).

Support for the argument that the external canal is not concerned in continued labyrinthine tonus is perhaps found in the pathological material provided by the authors. Were the external canal so concerned, unilateral paresis of recent origin would inevitably be associated with the occurrence of directional preponderance of nystagmus. But external canal paresis without associated directional preponderance of nystagmus is recorded even in cases where the short duration of labyrinthine symptoms suggested recent onset of the canal paresis.

The balance of evidence available would seem to suggest that the external canal is not concerned in the origin of the constant labyrinthine tonic influence. There does not, however, appear to be any evidence which would exclude the superior and posterior canals from being so concerned; these canals are relatively less sensitive to endolymph flow than is the external canal (Bárány); in many ways they are synergic with the utricle, and they may well be concerned with the latter in continued labyrinthine tonus. For convenience of nomenclature, it is probably well to agree with Cawthorne, FitzGerald and Hallpike, and to speak of utricular tonus and of utricular lesion as being the vestibular cause of a directional preponderance of nystagmus. But that the utricle alone is concerned is not proved.

**Ewald's law.**—The results of hot and cold caloric stimulation, using approximately equal thermal stimuli, both in normal subjects and in patients before and after unilateral labyrinthectomy, clearly demonstrate that in the human external canal ampullo-petal endolymph currents are not substantially (if at all) more effective than ampullo-fugal currents. Cawthorne, FitzGerald and Hallpike, by their strikingly simple experiments have clearly shown that Ewald's law relating to this is not applicable to the human external canal; interference with the normal balance of the continued tonus of the two labyrinths provides the explanation necessary of the phenomena following unilateral labyrinthectomy.

**Effects of caloric irrigation.**—If, however, conclusions are to be drawn from caloric tests as to labyrinthine physiology, or if pathological lesions are to be localized by such tests, certain considerations are first requisite.

Cawthorne, FitzGerald and Hallpike report that in their experiments ampullo-fugal endolymph currents in the external canal produce nystagmus normally (i.e. in 80% of their cases) of longer duration than ampullo-petal currents—i.e. that cold irrigation is more effective than hot, the tests being made in the ampulla-up (or face-up) position. This finding is in my view to be explained by the fact that equivalent thermal stimuli were not employed. The water in the storage can was in each test regulated to 7° C. above and 7° C. below 37° C. Owing to cooling in the can and in the delivery tubing, the water actually reaching the ear would be 5.7° C. above, and 7.5° C. below 37° C.—in other words the cold tests as applied afforded a substantially greater thermal stimulus than the hot.

A closer approximation to equal thermal stimuli would be obtained if the water in the storage can were adjusted to 44° C. and 31.8° C., but this would require to be adjusted for each series of tests, depending upon the size of the can, the length and thickness of the delivery tubing, the rate of flow of the water and the temperature of the room in which the tests are performed. Moreover one would think that not 37° C. but the ascertained internal temperature of each patient must determine the mean point in each case.

Considerable importance is to be attached to the determination of the normal relationship between the responses to cold and hot irrigation (C:H ratio) because from variations from an established normal we may learn to draw conclusions as to pathology and because the establishment of such a normal would remove one variable factor from our present caloric results and would thus result in greatly increased accuracy in their analysis.

Using equivalent thermal stimuli I have found that nystagmus after cold irrigation commonly is of slightly shorter duration than that after hot irrigation. The difference is small, and may well not indicate a differential sensitivity to the direction of endolymph flow but be peculiar to the caloric test, the crista being less sensitive when cooled and more sensitive when warmed.

**Extra-canalicular effects.**—Before conclusions as to the function of the external canal can be drawn from caloric tests, the possibility of results of irrigation other than mere canal stimulation must be considered. It may well be that cold and hot irrigations depress or stimulate the normal tonic impulses proceeding from the labyrinth of the irrigated ear. This was the explanation first provided to account for the phenomena following caloric stimulation, but was subsequently abandoned in view of the overwhelming evidence of thermal currents in the external canal. These currents must be the dominant factor, but if we are to base upon accurate caloric tests conclusions as to the physiology or pathology of the intralabyrinthine parts, we must consider the possible existence of other factors. Accepting the presence of continued labyrinthine tonus, which, if unbalanced, will produce spontaneous nystagmus or will increase or decrease nystagmus resulting from canal stimulation; it is then entirely to be expected that cooling of the labyrinth will decrease this tonus, and that warming of the labyrinth will increase this tonus.

The result of this would be to increase the nystagmus resulting from canal stimulation in the case of both cold and hot irrigation, if the external canal is in the ampulla-up position (i.e. the patient in the face-up position). In the ampulla-down (face-down)

position, however, the effect would be to decrease the nystagmus resulting from canal stimulation by both cold and hot irrigation.

I have examined eight patients in the manner suggested, using assumed equivalent thermal stimuli, and testing in the ampulla-up and ampulla-down positions. The tests are not easy of performance, and, while efforts have been made to secure equivalent conditions by affording similar fixation for the eyes and similar illumination, it has not been possible to avoid that congestion of the head and that muscular (and nervous) strain which must result in greater or less degree from the adoption of the ampulla-down position. That such factors may affect the duration of nystagmus is likely. Lorenté de Nó has stated that merely to tweak the tail of a rabbit which is the subject of experiment is to affect the duration of nystagmus, and de Kleyn and Versteegh are quoted by him as showing that irritation of the nose has a similar effect.

If these considerations are to be kept in mind, it may be stated that the results in the eight cases so tested by me show that the duration of nystagmus after caloric irrigation is consistently less in the ampulla-down than in the ampulla-up position, suggesting that cold irrigation may depress the normal tonus of the labyrinth, and warm irrigation increase it.

**Analysis of results.**—An accurate test demands accurate analysis. Consideration must then be given as to the margin which must be allowed for variations within the normal and for observational or experimental error.

In the diagnosis of pathological lesions Cawthorne, FitzGerald and Hallpike attach importance to the appearance of "patterns" on analysis of their familiar diagrams (calorigrams). These calorigrams are readily appreciated, but personally I have found it easier for purpose of analysis to record the results of the tests and the process of analysis in tabular form. Below appears a calorigram of an illustrative case, in diagrammatic and tabular form.

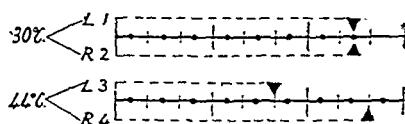


FIG. 1.

#### TABULAR EXPRESSION AND ANALYSIS OF CALORIC TESTS.

Pressure Expression and Analysis of Caloric Tests.												
		(a) Duration of nystagmus	(b) C > H	(c) Rt. ext. canal	(d) Rt. utricle	(e) Dis- crep- ancy	(f) Nystagmus	(g) Vertigo				
		Result	+10	+20	+20	20						
1	30°C	{ L. 2.30	2.30	2.50	2.50	2.50	2.50	Mod.	Slight			
2		{ R. 2.30	2.30	2.30	20	2.50	2.50	Mod.	Slight			
3	44°C	{ L. 1.40	10	1.50	20	2.10	20	2.30	20	2.50	Fine	Nil
4		{ R. 2.40	10	2.50	2.50	2.50	2.50	Mod.	Slight			

Column (a) Records Duration of nystagmus.

Column (b) Records the excess duration of the cold over the hot reactions.

Column (c) Records the excess response of the right external canal as compared with the left.

Column (d) Records the directional preponderance of nystagmus in terms of influence of the right utricle relative to the left.

Column (e) Records the discrepancy persisting after adjustment for the known factors (Cols. b, c, d).

Columns (f) and (g) record a description and comparison of the nystagmus and vertigo elicited in each test.

Column (a) Records Duration of nystagmus.

Column (b) Records the excess duration of the cold over the hot reactions.

Column (c) Records the excess response of the right external canal as compared with the left.

Column (d) Records the directional preponderance of nystagmus in terms of influence of the right utricle relative to the left.

Column (e) Records the discrepancy persisting after adjustment for the known factors (Cols. b, c, d).

Columns (f) and (g) record a description and comparison of the nystagmus and vertigo elicited in each test.

Multiple manipulations of the figures are proper to determine the presence of "pattern reactions". Lines 1 and 2 (or 3 and 4) may be added to (or subtracted from), to compensate a variation in the Cold:Hot ratio. Lines 1 and 3, or 2 and 4, may be added to, or subtracted from, to compensate a canal paresis. Lines 1 and 4 (or 2 and 3) may be added to, or subtracted from, to compensate a directional preponderance of nystagmus caused by (in the absence of cerebral lesion) an alleged utricular paresis.

It will be seen that the possible manipulations are numerous; all must be practised in one case if necessary to achieve an approach to symmetry of the reactions.

It is clearly possible to obtain a "pattern reaction" in every calorigram with rare exceptions. Such an exception would be the recording of exactly equal duration of nystagmus in all four tests, or the finding of three equal reactions with one only at variance. In manipulating the figures to determine "patterns", it is proper to vary simultaneously any combination of two figures, but never one figure only. Such a variant figure must remain variant with the other three. This persistent difference may be described as a discrepancy, for our present theory and present knowledge permit no explanation. Such a discrepancy is also frequently found in cases where the figures have been adjusted in correction of the pathological patterns noted—the adjustment has secured an approach to symmetry, but one figure remains at variance.

The occurrence of these discrepancies is of great importance. They have been numerous in the seventy subjects whom I have examined; they occur in the published cases of Cawthorne, FitzGerald and Hallpike.

In making each test the examiner should have in front of him the records of the estimated degree of nystagmus and sense of vertigo elicited in previous tests, but it is important that he should be ignorant of the duration of nystagmus in previous tests, the

record of which when made should be obscured. Further the examiner should be ignorant of the passage of time until he has declared that the nystagmus is no longer visible. Neglect of these precautions may influence undesirably the results, more particularly when the point to be determined is the assumed end point of visibility of a gradually diminishing nystagmus.

Discrepancies may be due to observational error, but they are certainly not always to be so explained, nor by error in technique. If such factors are responsible, which is the figure at fault, the obvious variant, or one of the others? If the latter, two figures are now capable of adjustment, and obviously a pathological pattern reaction may have been misdiagnosed or missed. In other cases, where the discrepancy is real, no explanation can be afforded; it may be, as previously suggested, that caloric irrigation does more than stimulate the external canal and cause exhibition of imbalance of labyrinthine tonus; it may be that the caloric tests can demonstrate pathological lesions other than canal paresis or utricular paresis. The mere possibility should encourage a healthy but reasonable scepticism in the interpretation of the results of caloric tests.

Emphasis has been laid upon the great facility with which pattern reactions can be obtained in most calorigrams, and upon the frequent occurrence of discrepancies because a valuable method of testing will fall into disrepute unless considerable conservatism is exercised in assessing results. For the present vestibular lesions must be diagnosed only when the reactions obtained are typical and considerable.

Reactions in disease.—Cawthorne, FitzGerald and Hallpike's observations on the occurrence of directional preponderance of nystagmus in temporal lobe lesions are most valuable, as is their observation that they have not seen it in cerebral lesions not affecting the temporal lobe. It is, however, interesting that the case of de Kleyn and Versteegh quoted by them was an abscess not of the temporal lobe but of the frontal lobe, yet exhibited directional preponderance of nystagmus. It may well be that the abscess was a large one, secondarily affecting the temporal lobe, but in their paper de Kleyn and Versteegh do not state this.

While directional preponderance of nystagmus resulting from imbalance of labyrinthine tonus disappears as compensation becomes established, this apparently does not occur when the lesion is in the cerebrum or tracts. I have seen a clear-cut directional preponderance of nystagmus to the right of 35 seconds in a man aged 35 exhibiting a congenital left hemiplegia with left Horner's syndrome, diagnosed as syringobulbia but perhaps Little's disease.

In dealing with "Ménière's" disease, Cawthorne, FitzGerald and Hallpike, in my view, in a small proportion of cases attribute to pathological changes in the vestibule reactions which are within the bounds of the normal or of observational error.

An interesting feature emerges from study of their findings in these cases of "Ménière's" disease. In any particular case the actual duration of caloric nystagmus is an unreliable indication of the vestibular function, but from the average of a number of cases a conclusion may be drawn.

In fifty normal controls Cawthorne, FitzGerald and Hallpike record that less than 20% showed nystagmus lasting more than 2 min. 10 sec. Their recorded cases of "Ménière's" disease showing "canal paresis" only—i.e. excluding cases exhibiting directional preponderance, which would tend to prolong the nystagmus, excluding also three cases described by the authors as showing canal paresis only, but which in my view show also directional preponderance (Cases 31, 34, and 39)—these cases of "canal paresis" only show nystagmus lasting more than 2 min. 10 sec. more than twice as often as do the normal controls; in 12 of the 26 cases. If cases with clear-cut paresis are excluded the percentage of the remainder with this excess reaction is of course very much higher.

The symptoms of "Ménière's" disease are now coming to be accepted as being due to an asymmetrical vestibular paresis. While this is undoubtedly in many cases true, the above figures would suggest that in a proportion of cases there is still room for a diagnosis of local hypersensitivity, or, perhaps, of a lack of central inhibition, as being responsible for the symptoms.

#### SUMMARY

Consideration is given to various problems discussed in Cawthorne, FitzGerald and Hallpike's recent progressive papers dealing with the human vestibular function with particular reference to the caloric tests. The seat of origin of labyrinthine tonus is discussed.

The thesis is accepted that the human external canal exhibits no marked difference of sensitivity to endolymph flow in one or other direction.

Consideration is given to the possibility that the caloric tests elicit responses other than those due to endolymph flow notably by affection of labyrinthine tonus.

The analysis of the results of the caloric tests is discussed.

The results of the caloric tests in pathological states is considered. "Ménière's" disease may usually be accompanied by an asymmetrical vestibular paresis but in some cases hyperexcitability of the organ cannot be excluded.

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Squadron Leader G. H. Bateman, R.A.F.V.R., said that in the discussion so far as it had proceeded no mention had been made of the superior and posterior canals. He wondered whether Mr. Hallpike considered that the external canal had a preponderating physiological effect or whether all the canals had equal, though different, effects, and the external canal was discussed only because it was the easiest one to investigate.

Mr. H. V. Forster said it had been mentioned that sensitivity might be a cause of vertigo and in America he believed that allergy had been blamed for this symptom. Torsten Skoog of Lund, though aware that brain tissue was resistant to sensitization, had claimed that a sharply defined area in the medulla was not resistant (*Acta otolaryng.*, Stockh., 1937, 25, 365). He thought that this result of his experimental work was of interest to those seeking an explanation for certain attacks of vestibular vertigo, because of the proximity to the area of the vestibular nuclei. Mr. Hallpike's researches had demonstrated pathological changes in the end organ—the labyrinth—but did he think that changes in the central nervous system might also be at fault in some cases?

He believed that Thornval had once expressed the view that symptoms of vestibular vertigo might arise from disturbances in the medullary nuclei.

In the treatment of "Ménière's" syndrome he had found bulbocapnine useful, particularly during the acute attack.

Mr. Hallpike, in reply, said, with regard to Major Clarke's remarks, he was indebted to him for examining this work with such care and skill.

With regard to the question asked about the superior canals, the part played by the vertical canals was not known. As to the explanation of the greater effect of the cold stimuli, Major Clarke had pointed out very properly that although they had selected 30° and 44° C. respectively, it was very likely that the hot water lost heat at a greater rate than the cold in the course of running it in, and that this was a factor in the smaller responses usually obtained to hot stimulation.

In some of the published results the abnormalities appeared small, but he and his colleagues had pointed out that it was not only the time difference but the general amplitude which played a big part in arriving at a decision. Small time differences accompanied by big differences of amplitude of nystagmus were, they thought, significant and the cases which Major Clarke was referring to were of that kind. He would have thought that the establishment of these tests on a firm statistical basis was a matter of difficulty which could not be got over very quickly. It was important to have delicate tests of this kind.

With regard to the point made by Mr. Forster, the fact that gross changes of a constant type did occur in the labyrinth did suggest that the labyrinth was the principal seat of the disorder. There was no reason why the changes in the labyrinth should not to some extent have an allergic basis, and he had met one or two cases in which it was said very definitely that an attack could be produced by eating such food as cauliflower. But those cases were very rare.

## Section of Urology

President—H. L. ATTWATER, M.Ch.

[May 27, 1943]

### DISCUSSION ON THE RELATIONSHIP OF HYPERTENSION TO RENAL DISEASE

**Mr. Kenneth Heritage:** The death-rate from arterial hypertension is higher than that from cancer. In people over 50 years of age it is responsible for 23% of the total deaths. Hypertension is not, however, a disease entity; it is caused by or associated with fifty morbid states. Moreover most patients suffer from the essential or malignant variety of hypertension, the aetiology of which is uncertain. The term essential hypertension is therefore a confession of ignorance and therein lies its chief value.

Albutt in England and Huchard in France about 1895, first drew attention to cases of long-standing hypertension unassociated with clinical evidence of previous nephritic or vascular disease, thus differentiating hyperpiesia, the cause of which is unknown, from hypertension secondary to renal disease. Such cases of hyperpiesia may show an hereditary tendency; hypertension commonly shows itself in early adult life; it may remain stationary for many years or show wide variations in the individual case, but sooner or later deterioration and death occur, downward progress being particularly rapid when the level of 200 mm.Hg or over is reached. These wide variations, the temporary improvement in the blood-pressure with rest, and the ageing factor must constantly be borne in mind in studying these cases and in assessing the results of treatment.

Of recent years the conception of an extrarenal cause for essential hypertension has been called in question by experimental work, and clinicians' attention has turned again to the kidney in the investigation of these baffling cases. Goldblatt in 1934 produced sustained hypertension in dogs by two methods and thereby established on firm basis a renal origin for at least one variety of hypertension, first by *partial* constriction of *both* renal arteries by screw clips, and secondly by partial constriction of one renal artery followed by removal of the opposite kidney. The presence of the normal kidney tends to prevent hypertension developing.

Wilson and Byrom showed that constriction of *one* renal artery resulted in permanent hypertension in rats and that subsequent changes took place in the opposite unclamped kidney essentially similar to those seen in malignant hypertension in man. The effects of experimental hypertension on the normal kidney could thus be studied.

The degree of hypertension varies with the degree of constriction. Moderate constriction results in hypertension which corresponds with benign hypertension in man whereas severe constriction results in severe vascular changes in all organs except the constricted kidney which is protected from the effects of hypertension by the clamp. When clamps are applied to both renal arteries, both kidneys are protected from the vascular changes.

Thus whilst renal ischaemia causes hypertension, hypertension is capable of producing all the vascular changes in the kidney formerly regarded as chronic nephritis. Since these changes increase the renal ischaemia, a vicious circle is set up.

If the ischaemic kidney is removed or the clamp removed and the vicious circle thereby broken before vascular changes in the other kidney have become permanent or widespread, the blood-pressure returns to normal, but if months have elapsed and the secondary vascular changes become well established these in turn maintain the ischaemia and hypertension, and by causing fresh vascular damage lead to rapid deterioration in the terminal stages.

Ischaemic hypertension is affected by the patency of the ureter. If the ureter is also ligatured no hypertension develops, although a smaller quantity of pressor substance can still be demonstrated in the blood from the renal vein. Removal of the opposite kidney results in hypertension. Ligature of the ureter after ischaemic hypertension has been produced results in a fall of the pressure to normal.

Bilateral adrenalectomy also completely eliminates the response to constriction of the renal arteries and Page has shown that the adrenal cortex or the administration of

its extract in substitution therapy is necessary for the production and maintenance of the hypertension of experimental renal ischaemia.

Goldblatt reports that the hypertension induced by his clamp is not lowered by pentothal, pentobarbital sodium, chloralose or morphia, but is lowered by amyl nitrite, glyceryl-trinitrate and high doses of potassium thiocyanate.

Whilst the existence of experimental hypertension is undoubted, its mode of production is by no means established. That it is not due to a nervous reflex is shown by the facts that it cannot be prevented or relieved by denervation of the renal pedicle, excision of the splanchnic nerves, complete sympathectomy or by destruction of the spinal cord. Therefore the mechanism of production is probably chemical by means of a pressor substance. Such a pressor substance (renin) derived from the cortex of the kidney was described as long ago as 1898 by Tigerstedt and Bergman. When isolated kidneys are perfused with blood no pressor substance is liberated so long as the pulse pressure is normal, but sharp reduction of the pulse pressure or the conversion of a pulsatile to a continuous flow of blood leads to abundant liberation of pressor substance. Thus true ischaemia need not occur.

Renin has been isolated and its properties studied. When injected intravenously it produces a rather slow rise in blood-pressure. When perfused *with* blood it causes vasoconstriction but not when perfused with Ringer's solution. This led to the discovery that renin acts by combining or reacting with the pseudoglobulin fraction of the plasma proteins forming angiotonin or hypertensin. This substance has been isolated and actually crystallized. In its properties it is quite unlike renin, being much more stable, will withstand boiling, and intravenous injection produces a prompt rise in blood-pressure. Its action is greatly reduced or nullified by the presence of normal kidney tissue from which an antipressor enzyme can be isolated. This enzyme, which has the power of destroying or neutralizing the pressor effect of angiotonin, has been extracted and used with effect in the reduction of experimental hypertension in animals and of essential hypertension in man (fig. 1).

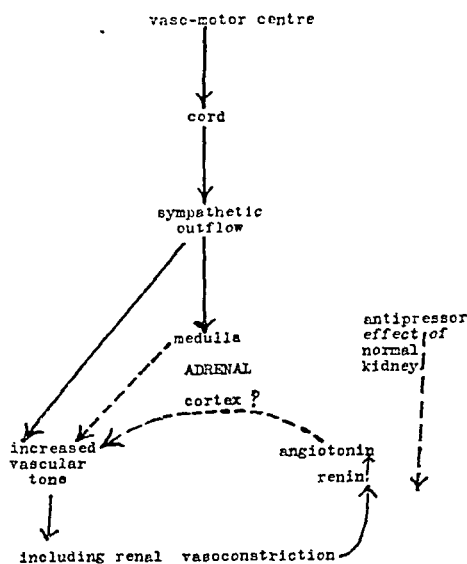


FIG. 1.

Whilst the production of such antipressor substance and its use in the therapy of essential hypertension holds out some promise, it cannot yet be regarded as in anything but the earliest experimental stage.

Decreased blood flow through the kidney and thence hypertension can be produced in many ways experimentally: (1) By removal of large portions of total kidney substance but not by total removal. (2) By partial ligation of the renal arteries (Janeway). (3) By constriction of the renal veins (Bell and Pederson, Braun-Mcndez). (4) By constriction of the kidney by cellophane perinephritis (Page). (5) By production of renal

fibrosis by X-rays (Hartman, Ballinger and Doub). (6) By compression of the renal arteries by adjustable clamps (Goldblatt, Wilson and Byrom). (7) By constriction of a solitary kidney transplanted to the groin (Glenn, Child and Heuer). (8) By ligation of both ureters. (9) By placing a ligature which while not constricting, limits the growth of the renal artery in young animals (Drury).

Some of these methods are analogous to clinical disease in man but the parallel cannot be closely drawn and experimental evidence should serve only to suggest lines of clinical research.

Turning from the experimental work to clinical surgery: If we exclude endocrine diseases associated with hypertension such as pituitary basophilism, arrhenoblastomata of the ovary, adrenal cortical tumours, paragangliomata of the adrenal medulla, &c., surgical interest in hypertension falls into three groups of cases: (1) Hypertension associated with bilateral renal disease, chiefly bilateral urinary obstruction with or without infection. (2) Hypertension associated with unilateral renal disease. (3) Essential or malignant hypertension in which evidence of a primary renal lesion is absent or doubtful.

#### (1) HYPERTENSION ASSOCIATED WITH BILATERAL RENAL DISEASE

Taking the first of these groups, even before clinical sphygmomanometry was possible, the association between cardiac hypertrophy and obstructive lesions of the urinary tract was noted. Potain in 1875 noted this occurrence in cases of prostatic hypertrophy. Since then it has been a common observation to find hypertension associated with chronic urinary obstruction due to prostatic enlargement, urethral stricture, bilateral ureteric calculi, ureteric obstruction due to inflammatory or neoplastic infiltration, tabetic bladder dysfunction and a variety of other obstructive lesions. In many, particularly the older patients, this may be a chance association, but a fall in blood-pressure followed by the maintenance of a permanently lowered level is sufficiently frequently observed to be a commonplace. Although these patients are often of advanced age and have long-standing urinary back-pressure, the hypertension is of a particularly benign type and responds well to drainage. I believe that hypertension with or without gross arteriosclerosis even in the absence of a raised blood urea is an indication for two-stage prostatectomy, and that this decompression of the vascular system is no minor contribution to the benefits of prostatectomy.

Uræmia and hypertension are not necessarily associated. Back-pressure uræmia may be present with a normal blood-pressure. Conversely hypertension may be present with a normal blood urea.

The following case is a common example in prostatic surgery.

A man aged 64 gave a two months' history of severe prostatic obstruction and of retention with overflow. The bladder was painlessly distended to the umbilicus. The urine was clear and uninfected. The blood urea was 82 mg. The blood-pressure whilst at rest was 210/130. Drip decompression of the bladder was carried out after which the blood urea fell to 58 mg. and the Van Slyke urea clearance test was 40% of normal. Two-stage prostatectomy was carried out as the blood-pressure had fallen to 120/70 at which level it now remains six months after operation.

In calculus anuria the blood-pressure rises sharply and commonly falls to normal when the urinary obstruction is relieved.

In anuria due to sulphapyridine crystals a similar sharp rise in blood-pressure is observed.

When investigating cases of hypertension the possibility of lower urinary obstruction should always be borne in mind. Difficulties are encountered as shown by the following case.

A man aged 58 is recorded as having had a blood-pressure on repeated examination of around 148/100 in April 1938. In December 1940 left nephrectomy was performed for stone in Sydney, N.S.W.; the right kidney being normal. A vesical calculus was also crushed. Since May, 1942, the blood-pressure has risen steadily to 240/140 and presumably will continue to rise. He has no urinary symptoms except nocturnal frequency. The urine shows no evidence of pus, blood, casts, or organisms. Urea concentration test shows maximal concentration of 1.7%, urea. Cystoscopy shows moderate prostatic enlargement with 4 oz. of residual urine. Both ureteric orifices are so grossly dilated and patulous that they look like the mouths of diverticula. The left leads to a sausage-shaped saccular dilatation of the stump of the left ureter in which a ureteric catheter coils up. The right shows considerable ureteric and pelvic dilatation, and a cystogram shows backflow up the ureters. Is his hypertension accidentally associated with a urinary lesion? Is it due to irreversible changes set up by the removed left kidney or is it in any way related to the mild though definite degree of prostatic obstruction now present?

Congenital polycystic kidney is associated with hypertension in over 50% of cases and the clinical course and sequence of events closely resemble that of chronic nephritis.

## (2) HYPERTENSION ASSOCIATED WITH UNILATERAL RENAL DISEASE

We turn now to the important group of cases of hypertension associated with unilateral renal disease. Since the work of Goldblatt followed by Wilson and Byrom, clinicians have been on the look out for cases of hypertension with evidence of unilateral disease in the hope of relief by nephrectomy.

Statistics differ as to the frequency with which these conditions are associated, yet whilst far from common, the relationship between the two conditions is in some cases undoubted.

In some cases particularly in children, it seems probable that the unilateral renal lesion is the sole cause of the hypertension as in the experimental animal. The frequency of unilateral renal disease and the comparative infrequency of its association with hypertension lends support to Braasch's view that the renal lesion serves as an irritant to bring out a latent hypertension, or hereditary tendency.

Whilst a dramatic fall in blood-pressure to normal often follows nephrectomy, and although this reduction in blood-pressure is maintained for weeks or months, in the majority of cases, probably due to secondary vascular changes in the other kidney and elsewhere, a steady upward creep of the blood-pressure is noted until in many cases the original reading is reached. Particularly is this the case in adult and elderly patients. In these cases although the presence of hypertension is to be taken into account in borderline problems, the decision between nephrectomy and conservative surgery must be dictated in the main by the extent of the surgical renal disease. In the present state of our knowledge, the sacrifice for a minor lesion, of a kidney which at a later date can ill be spared, must be guarded against.

The unilateral lesions most frequently associated with hypertension are atrophic pyelonephritis, hydro- and pyo-nephrosis with or without stone, and vascular lesions of the kidney.

*Atrophic pyelonephritis* is an unsatisfactory term used to denote a small poorly functioning infected kidney. Many are contracted as a result of chronic infection and fibrosis, but probably the majority are chronically infected due to some congenital abnormality: aplasia or hypoplasia due to insufficient blood supply. In these cases it seems that Nature has anticipated Drury's experiments. This congenitally hypoplastic theory is supported by the fact that these kidneys are frequently the cause of hypertension in children.

The first successful case of this kind recorded by Butler in 1937 is of a boy aged 7 whose unilateral pyelonephritis continued after removal of a stone. The blood-pressure gradually rose to 160/105 and after nephrectomy fell to 100/70. Twenty months later the blood-pressure was 115/75 and the child remained well. Barney and Suby record the association of a blood-pressure of 190/120 with a functionless right kidney in a child aged 10. Twenty-one months after nephrectomy the blood-pressure was 92/50.

Hypertension of the malignant type associated with renal hypoplasia has been known for some time. Schwartz in 1924 described a fatal case in a child, in which the smaller kidney weighed only 6 g. compared with its fellow of 150 g.

Fishberg in his monograph states that hypoplasia of one kidney is not a rare finding in a young person who has succumbed to malignant hypertension.

A beautiful example has recently been described by Platt.

A girl aged 8 suffered from *Bacillus coli* infection in a functionless left kidney. Severe headache, morning vomiting, cardiac enlargement, bilateral papilloedema and retinitis, and raised blood non-protein nitrogen were present with a blood-pressure of 200/120. The urine showed a trace of albumin but no pus or casts.

After nephrectomy the blood-pressure fell during the next five months to 125/70 and all symptoms and signs cleared up completely.

Examinations of the specimen showed healed pyelonephritis in a congenitally hypoplastic kidney. No main renal artery was found, its place being taken by four tiny vessels.

Although in this case nephrectomy was successful, though performed at a late stage in the disease, it is obviously highly desirable to remove the diseased kidney before the malignant phase and before the vicious circle of irreversible changes has been set up in the opposite kidney and elsewhere.

Wilson and Chamberlain reported a similar case in a girl of 12, whose blood-pressure of 230/170 was associated with a functionless right kidney. The urine contained a trace of albumin, a few pus cells but no casts. Forty-eight hours after nephrectomy the blood-pressure had fallen to 130/90 but at the end of ninety-six hours had risen again to 200/140. During the next two months a gradual fall took place and one year after operation it was found to be 116/74.

Burkland recorded an example of a congenitally hypoplastic pelvic kidney which from the age of 3 was known to be associated with hypertension up to 175/120. This hypertension was watched for two years till at the age of 5½ nephrectomy was carried out.

The renal artery was found to be partially occluded. A marked fall in blood-pressure followed operation and three and a half years later showed a reading of 105/65.

Many similar cases are recorded in children and adults although few have yet been followed sufficiently long after operation for the ultimate results to be known.

It is clear, however, that every case of hypertension particularly in children merits complete urography.

In adults the results are much less striking. It is to be assumed that the child's vascular system is much more adjustable and that the permanent changes are less marked.

Abeshouse records the case of a man aged 52 who suffered from left hydronephrosis associated with pelvi-ureteric obstruction. The blood-pressure varied between 200 and 210 systolic and 110 and 120 diastolic. Temporary improvement followed a plastic operation, the blood-pressure falling to 170/110, but the hydronephrosis recurred and ruptured spontaneously, giving rise to a perinephric abscess. Nephrectomy was performed and he was subsequently observed for three years during which time the reading remained constant at about 152/108.

*Partial ureteric or pelvic obstruction in producing hydro- and pyo-nephrosis* must commonly produce much elongation, distortion and compression of the renal arteries and pressure ischaemia of the renal tissue. Hypertension might be expected as a common finding. This, however, is far from the case and in some cases in which it is present and greatly benefited by nephrectomy, the specimen shows only very little renal tissue left in the wall of the sac, as in the following case.

A man aged 42 was first seen in October, 1937, when he complained of severe headaches, palpitations and dizziness of a few weeks' duration. He had occasionally passed dark urine suggestive of haematuria. Examination showed cardiac enlargement with an apical systolic murmur and a blood-pressure of 236/134. The retinal vessels showed sclerosis but no papilloedema was present.

No abnormality was palpable in the abdomen.

He was admitted as a case of essential hypertension to the medical side of the hospital, and investigated as follows:

Blood Wassermann negative.

Urine shows no red or white blood cells and no casts; later hyaline casts were found in moderate numbers.

Blood urea was about 40 mg. on repeated examination.

The urea concentration test showed a concentration up to 4% in the third hour.

The standard urea clearance test showed a clearance of 84% in the first hour and 60% in the second hour.

With rest in bed for two weeks the blood-pressure varied between 220/130 and 170/100, the latter figure being obtained after subcutaneous injection of vagotonin of which he had 17 daily injections. One month later his blood-pressure was again 250/150 and his symptoms were particularly severe. Radiological examination was now carried out showing no uroselectan excretion from the left kidney whilst the right showed no abnormality. Unfortunately these films were destroyed by bombing. Blood-pressure was observed two-hourly for two days (see fig. 2).

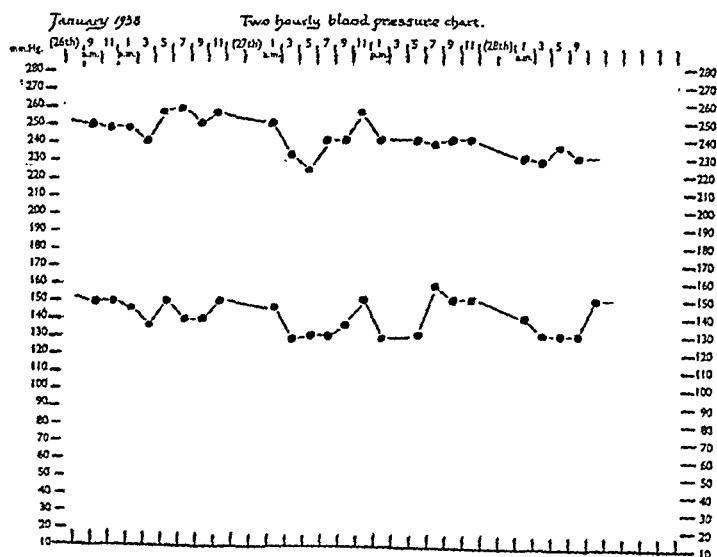


FIG. 2.—Patient J. L. (Princess Beatrice Hospital, No. 20357). Two-hourly blood pressure chart before operation.

On February 3, 1938, five months after the onset of hypertensive symptoms, left nephrectomy was carried out.

The blood-pressure immediately prior to operation was 230/140 and dropped to 180/100 under pentothal anaesthesia.

The usual loin incision was employed and a large pyonephrotic kidney found containing urine rich in cholesterol crystals. The renal tissue was compressed to a thin fibrotic shell and the upper end of the ureter was occluded.

He has been re-examined recently—five years after nephrectomy. He has remained completely well and his present blood-pressure whilst ambulatory is 150/75 (see fig. 3).

The urine shows no abnormality.

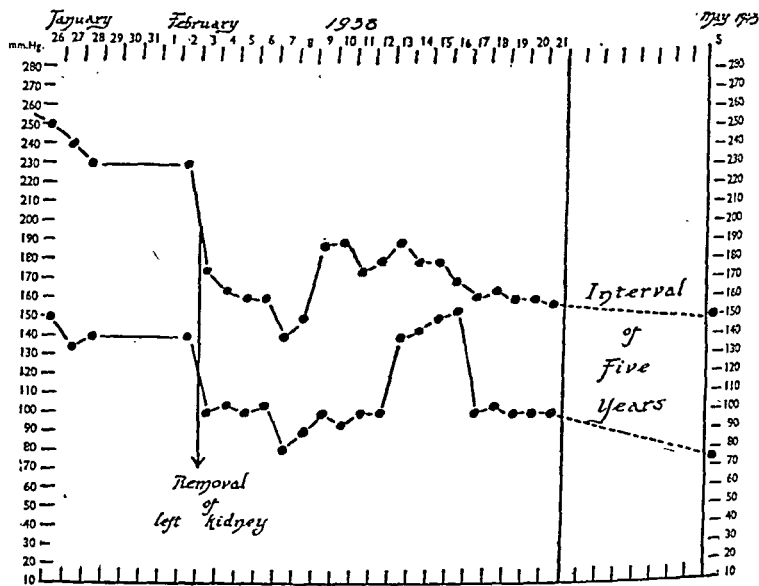


FIG. 3.—Blood pressure chart of J. L. (Princess Beatrice Hospital, No. 20387) showing the effect of nephrectomy.

It is to be noted that in this case there was only a five months' history of hypertension and its vasospastic nature was suggested by the marked fall under pentothal anaesthesia. I am indebted to my colleagues at the Princess Beatrice Hospital for their records of this case.

The following case illustrates the opposite extreme:

A woman of 62, known to have had tuberculosis of the left kidney for many years, was admitted in a state of stupor. Blood-pressure 220/120. Retinal hæmorrhages, macular star, marked papilloedema. Blood urea, 77 mg. Urea clearance 22%. The urine was loaded with albumin but contained no pus cells or casts. Marked left ventricular hypertrophy and peripheral vascular thickening were present.

Intravenous urography showed no function in a partly calcified left kidney, whilst the right showed only slight pelvic enlargement and was fairly well outlined.

She died of cardiac failure six weeks later.

Renal tuberculosis is not commonly associated with hypertension although Braasch found it in 13% of autonephrectomized kidneys such as this. Nesbit and Ratliff report a case of a woman aged 51 whose blood-pressure of 180/100 fell to 120/100 and remained at this level for fourteen months following removal of a tuberculous right kidney. It is noted that these cases are older than the average case of renal tuberculosis.

Renal calculus is not commonly associated with hypertension although the degree of chronic infection and renal sclerosis commonly associated would be expected to be productive of renal ischæmia.

Possibly stone earlier than other lesions draws attention to its presence and dominates the clinical picture, or in more long-standing cases, urinary obstruction negatives the hypertensive effect of vascular constriction as in cases of pyonephrosis.

I am indebted to Mr. Alex Roche for the following case:

A woman aged 54 gave a history of hæmaturia and pain in the left loin. The urine contained *Bacillus coli* and the radiograph showed an atypical stone in the outer part of the left renal pelvis and the function of the left kidney was severely reduced, the right being normal. The blood-pressure was 190/120.

Left nephrectomy was performed and the specimen, which was shown at the pathological meeting of this Section last year, showed an encapsulated stone adjacent to which was a squamous-celled carcinoma of the renal pelvis. The kidney was hollowed and contained blood. Four days later the blood-pressure was 186/92 and six weeks after operation 174/84.

This case is of interest in showing the unusual feature that the post-operative fall in blood-pressure is most marked, indeed almost entirely confined to the diastolic reading.

Very little evidence is available concerning the relationship of hypernephromata to hypertension. Although in the age group to which many of these cases belong hypertension is naturally common, few appear to be relieved by nephrectomy. This is rather unexpected in view of the frequency with which the renal vein is invaded by growth.

I am aware of a case in which visual impairment and fundus changes were associated with a systolic pressure of 180. Hæmaturia, however, led to the discovery of a small hypernephroma, the removal of which produced a rapid fall in blood-pressure to 120 systolic and the disappearance of all symptoms.

Even extreme hypertension is frequently seen with Wilms' tumours in children and Koons records a fall in blood-pressure from 190/155 to 116/76 following nephrectomy.

Whether ischæmia of renal tumour tissue like ischæmia of typical renal tissue can cause hypertension is not clear.

Again we have no convincing evidence that nephroptosis is associated with orthostatic hypertension.

In spite of Page's experimental findings with cellophane perinephritis, there is no evidence that perinephritis or perinephric abscess is ever an ætiological factor of hypertension in man.

*Vascular lesions of the kidney.*—From animal experiments it would be expected that hypertension would be a more constant feature of vascular renal lesions than other sclerotic disease, provided that the vascular change is one that results in a constriction rather than occlusion of the individual vessels.

Since localized or diffuse arteriosclerotic disease commonly is the result of hypertension, it would clarify the problem if such cases were for the time being excluded, and evidence sought amongst conditions in whose causation hypertension can play little part.

Welty recently collected 11 cases of thrombosis of the renal artery, a condition which is frequently mistaken for an acute abdominal catastrophe. Hypertension was present in every case.

Fishberg noted the development of transitory hypertension associated with embolism of the renal artery in a case of myocardial infarction. The blood-pressure was observed to be 100/60 for two weeks before the renal embolism following which it rose to 155/108 subsiding to normal again in five days.

It would seem that complete occlusion as in renal infarction is associated with transient or no blood-pressure changes.

A review of the literature of periarteritis nodosa reveals that hypertension is an almost constant finding in cases with renal changes.

Braasch, Walters and Hammer observed hypertension in two cases following severe renal injury. These authors have emphasized the role of operative trauma and infection as ætiological factors in hypertension. They reported 14 cases in which the blood-pressure was normal prior to conservative renal surgery but hypertension followed operation. Each case presented evidence of reduced function and persistent infection following the conservative operation and after removal of the diseased kidney the blood-pressure returned to normal.

Aneurysm of the renal artery is a rare condition but a recent report of this condition by Howard Forbes and Lipscomb is extremely instructive.

A girl aged 5 who gave a past history of acute hæmorrhagic nephritis following a throat infection was known to have a normal blood-pressure until August 1939 when she complained of headache and a left hemiparesis. At this time the blood-pressure was 158/90, and the urine contained a trace of albumin and a few casts. A craniotomy was performed at Johns Hopkins Hospital for right frontal hæmorrhage and although little abnormal was found the neurological signs cleared up. By this time the child's pressure had risen to 190/140 and when taken hourly for twenty-four hours the lowest reading obtained was 168/132.

The fundi showed only arterial constriction.

Intravenous and retrograde pyelography showed good excretion on both sides; the left renal pelvis was normal but the right showed slight dilatation of the lower calyx. Since as a last resort Adson's sympathetomy had been decided upon, the right side was chosen first. In October, 1939, right splanchnicectomy and removal of the celiac and the first, second and third right lumbar ganglia were carried out. Although after this operation evidence of sympathetic interruption was noted, no fall in blood-pressure occurred.

Two weeks later a similar operation was performed on the left side. Splanchnicectomy and ganglionectomy were done first and the usual fall in blood-pressure did not occur.



Gerota's capsule was then opened with a view to renal decapsulation. The kidney was found to be normal but attached to the pedicle was a multilocular aneurysm of the renal artery the size of three small grapes. At this moment the blood-pressure was 170/100. Nephrectomy was immediately carried out and five minutes later the pressure had dropped to 126/80. The kidney showed hyaline necrosis of the glomeruli, degenerative changes in the tubules and intimal proliferation.

Three weeks later on discharge from hospital the reading was 138/90, and five months later 110/70. The child remained in good health nine and a half months after operation.

This case illustrates the fact that a kidney may show no difference from its fellow in the excretion of uroselectan and may show a completely normal pyelogram and yet be the unilateral cause of hypertension.

### (3) ESSENTIAL HYPERTENSION

In the search for clinical renal ischaemia we are handicapped by the absence of any means of visualizing the renal arterial tree in life and although uroselectan clearance tests and intravenous pyelography afford evidence of total renal blood flow—the blood being practically cleared in a single passage through the kidney—they afford no evidence of degrees of vascular obstruction.

In this connexion it is interesting to note that Corcoran and Page found no depression of renal function to urea, inulin, uroselectan or phenol red clearance tests in hypertension induced by either cellophane perinephritis or by arterial constriction.

It cannot be too strongly emphasized that it is exceptional to find a gross surgical renal lesion associated with hypertension and it is always possible for the association to be a chance one. The great majority of our cases therefore remain in the unknown or essential group, and there is no evidence that the kidney is primarily responsible for this condition. In cases of malignant hypertension dying early in the course of the disease from a non-renal cause post-mortem renal changes are minimal or lacking; arteriolar necrosis being the earliest change.

From our knowledge of the effects of severe hypertension on the kidney, it is tempting to suggest that some vascular constriction, presumably vasospasm when organic change is absent, must have protected the kidneys from the otherwise inevitably severe vascular damage of hypertension.

Since angiotonin is both a result and cause of renal vascular constriction another vicious circle is evident.

It is probable therefore in early cases of essential or malignant hypertension that antipressor therapy if perfected, will find its chief application.

In the meanwhile sympathetic surgery has been applied extensively to these cases.

The sympathetic surgery of hypertension is based on the assumption that the increased arterial tone can be released by extensive sympathectomy and that a fall in blood-pressure follows such extensive vasodilatation. This fall in blood-pressure undoubtedly follows splanchnicectomy and is largely due to splanchnic vasodilatation which may be severe enough to produce extreme orthostatic hypotension. Other important factors are denervation of the adrenals with possible reduction in the release of adrenalin under conditions of stress, and the abolition of neurogenic renal vasospasm by renal denervation.

The latter factor would appear to be negligible except in emergencies of great sympathetic stimulation, for renal denervation alone has no effect either on the systemic blood-pressure or on the renal blood flow under normal conditions. In fact the kidney seems possessed of a remarkable degree of autonomous adjustment of its afferent and efferent arterioles by which in the face of changing arterial pressure it is able to maintain the renal blood flow constant, possibly also of altering the blood-pressure to maintain renal flow. Such vascular control must be humoral as it is uninfluenced by denervation.

Although an increased filtration fraction and a decreased renal blood flow, both explainable by efferent vasoconstriction, characterize essential hypertension in man, extensive sympathectomy has no effect in increasing the renal blood flow as measured by the abrodil clearance test, yet the maintenance of the pre-operative volume of renal blood flow in the presence of a lowered blood-pressure would suggest that some renal vasodilatation has taken place.

It would appear possible therefore that a reduction in blood-pressure by extensive vasodilatation and impairment of the output of adrenalin may in some way break the vicious circle of renal vasoconstriction.

One is, of course, well aware of the very strong evidence against hyper-adrenalinemia and the dissimilarity between the paroxysmal hypertension of adrenal medullary tumours and the cases under discussion.

As mentioned earlier, even total sympathectomy has no power in reducing hypertension due to a Goldblatt clamp, so if any comparison can be made from animals to man, the benefits of sympathectomy in essential hypertension must be ascribed to release of the physiological clamp, before anatomical changes have gone too far.

Four operative procedures have been used, and have gained widespread acceptance.

(1) Crile's operation of adrenal denervation and celiac ganglionectomy. Whilst Crile reports relief in over 50% of cases it is important to remember that sympathetic regeneration rapidly takes place.

(2) Peet's simultaneous bilateral intrathoracic splanchnicectomy and lower dorsal ganglionectomy. This has the advantage that both sides can be done at one sitting and since much of the division is pre-ganglionic, regeneration is less likely, but it suffers from the great disadvantage that the kidney, renal vessels and adrenals cannot be inspected and so lesions here may be missed. However Peet records over 40% of cases in each post-operative year up to six years as having marked reduction in blood-pressure, and of these about half showed either a return to normal blood-pressure, or a fall of 80 mm. in systolic and 25 mm. in diastolic pressure.

(3) The most popular operation of this type is Adson's subdiaphragmatic extraperitoneal resection of the splanchnic nerves, celiac ganglia and lumbar sympathetic chain, generally combined with partial adrenalectomy, renal denervation, decapsulation and biopsy. Whilst this has to be carried out at separate occasions on each side and though, in spite of its radical nature regeneration is possible, it has the advantage that a very complete inspection of the adrenals, renal vessels and kidney is an essential part of the operation.

(4) Recently Smithwick has still further extended this operation above the diaphragm to obtain preganglionic section, and has removed also the lower dorsal sympathetic chain and the supradiaphragmatic course of the splanchnic nerves. This operation when completed bilaterally is followed for a time by severe orthostatic hypotension, but for it Smithwick claims 65% of good results.

(The role of decapsulation in aiding collateral circulation is doubtful. There is doubt as to whether it aids in providing collateral vessels or whether like Page's cellophane, perinephritis is set up. This is quite apart from the question as to whether the constricted arterioles are ever reached.)

My small experience is limited to the extended Adson operation from which a substantial fall in blood-pressure is commonly obtained. Other cases in which the fall in blood-pressure is slight obtain a disproportionate amount of symptomatic relief and even retrogression of fundus changes.

It must be admitted, however, that if the evil consequences of prolonged hypertension are to be averted, substantial reduction in blood-pressure is necessary.

Loyal Davis has shown that splanchnicectomy even if unsuccessful in causing a significant fall in blood-pressure renders the patient more responsive to medical treatment with sodium thiocyanate.

In the absence of knowledge of the mode of action, the criteria for splanchnicectomy must be accepted with considerable reserve. Here are some that have been put forward.

- (1) The absence of any known endocrine cause.
- (2) The absence of any primary medical or surgical lesion of the urinary tract.
- (3) Systolic pressure of over 200, diastolic over 100.
- (4) Failure of medical treatment.
- (5) Full cardiac compensation. Absence of advanced sclerosis.
- (6) Normal blood urea.
- (7) Urea clearance test of 40% or over.
- (8) Progressively increasing symptoms.
- (9) Favourable response to rest, sodium amylal or pentothal sodium.
- (10) Age under 50.
- (11) Positive cold pressor test.

Many writers sound a note of warning on the dangers of a fall in blood-pressure. In none of the records I have studied have I found any evidence that a reduction in blood-pressure towards normal has been anything but beneficial.

In conclusion, it is clear that in investigating a case of unexplained hypertension a complete urological search is necessary. Although in the great majority of cases no surgical lesion will be found and great caution is necessary in interpreting the association between such a lesion and hypertension as cause and effect, only when such a cause is excluded can the case be regarded as one of "essential hypertension" for which extensive sympathectomy seems to hold out a chance of definite palliative benefit.

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Other workers have been more successful in their endeavours to produce hypertension with the varying types of kidney injury, but most are agreed that, with the one outstanding exception of renal ischaemia, the hypertension can be established with no degree of constancy.

Various explanations for the apparently fortuitous occurrence of hypertension after renal damage have been put forward. These postulate critical degrees of anoxaemia, excretory failure or the formation of substances that either directly or indirectly neutralize the action of the pressor substances. One fact does emerge, and that is that there is no parallelism between the occurrence of hypertension and the amount of renal disability. Recently, while endeavouring to reproduce experimentally the lesions of "crush kidney" C. A. Keele and I tried the effects of temporary occlusion of the renal circulation.

After occlusion of the renal circulation for periods varying between sixty to one hundred and twenty minutes, in the majority of animals the blood urea rises rapidly to 300 mg. per 100 c.c. Thence it may continue upwards to 600 or more or the animals may slowly recover. Although frequent blood-pressure readings were taken no significant rise of blood-pressure was found. [I am indebted to the Courtauld Institute of Biochemistry for these figures.]

On the other hand a high degree of hypertension can be established without any gross signs of kidney failure.

Megibow, Katz and Rodbard (1942) have stated that a certain amount of healthy kidney tissue is necessary for the production of hypertension and that there must be a balance between ischaemic and healthy kidney. It is not clear how this balance is maintained over long periods of kidney destruction.

On the question of the nature of essential hypertension, the above work taken in conjunction with the now classical experiments of Goldblatt *et al.* (1932, 1941) would appear to lend support to the view that this condition is the result of a humoral mechanism.

This view is substantiated by Wilson and Pickering (1938) and by Wilson and Byrom (1941) who show that clamping of one renal artery may be followed by the changes of malignant hypertension in the organs and in the untreated kidney. These authors believe that a vicious circle is set up. This evidence has been accepted by many as a clear indication of the renal-humoral origin of essential hypertension, but there is much that still requires explanation.

It is difficult to see how this vicious circle is maintained without the intervention of some other factor. It is not clear if the changes are brought about by the high blood-pressure or by the substances liberated from the affected kidney. It is well known that both clinically and experimentally lasting hypertension may be unaccompanied by kidney changes. Lasting high blood-pressure can be induced in rabbits by denervation of the carotid sinuses and even after long periods of hypertension no kidney changes can be demonstrated (Kremer, Wright and Scarff, 1933). If the pressor substance is directly responsible there is no explanation for the absence of lesions in the clamped kidney. It is true that its blood supply is reduced but its circulation is adequate and the circulating blood must contain the pressor substance.

I hope that other speakers will give the clinical evidence against the simple humoral view of hypertension. The work of Arnott and Kellar (1936) on the experimental side should be noted. They demonstrated a rise in blood-pressure in oxalate nephritis but found that this rise was prevented by previous denervation of the kidney.

Maegraith and Maclean (1942) showed that injections of kieselguhr into the renal cavity would produce a rise in blood-pressure in rabbits. They described two phases of the rise in pressure: (i) A transitory "spike" phase; (ii) a slower lasting rise.

Section of the renal nerves prevented the slow lasting phase or abolished it when established, but had no effect on the "spike" phase. This would indicate the operation of two distinct factors in the production of the hypertension.

From these facts it would appear that both humoral and nervous mechanisms may play a part in the production of hypertension but that knowledge of these alone is insufficient to explain the inconstant occurrence and variations in behaviour of the condition.

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**Dr. Horace Evans:** In spite of the advances in our knowledge of the natural history of kidney disease and the exciting work on experimental hypertension, we as yet know little of the mechanism of essential or primary hypertension—the disease which is responsible for perhaps more than 90% of all patients with high blood-pressure. Nor is there yet any adequate treatment of this condition—either medical or surgical.

At the present time, we recognize two main groups of patients with hypertension. In one, the hypertension is secondary to some obvious pathological state such as chronic nephritis, chronic pyelonephritis, polycystic kidney disease, toxæmia of pregnancy, tumours of suprarenal and pituitary glands, and coarctation of the aorta. In the other, the hypertension appears as the primary feature without obvious renal or other disease. This is the group known as essential hypertension. There are two types of essential hypertension: benign hypertension and malignant hypertension.

Benign hypertension is a disease of later life (50 to 60), and runs a course of many years, often symptom-free until some cardiac or cerebral catastrophe occurs. Papilloedema and renal failure do not occur. This condition accounts for the great majority of patients with high blood-pressure. The tolerance of women in particular to many years of this form of hypertension is notable.

Malignant hypertension appears to be a separate clinical entity. It is relatively rare, and occurs in a younger age-group (40 to 50), more commonly males, with severe symptoms such as headache, dyspnoea, and visual disturbances at the onset, and in the later stages renal failure is common with death within twelve to eighteen months of onset. Papilloedema is the early physical sign which immediately distinguishes this condition from benign hypertension. There is usually no record of previous hypertension. Occasional but rare instances occur when, after many years of benign hypertension, a malignant termination supervenes. This must not be confused with the clinical entity just described and for which the term malignant hypertension should be reserved.

The experiments of Goldblatt and Byrom and Wilson have led some to the belief that all hypertension is renal in origin. There is no doubt that, in certain instances, unilateral kidney disease (chronic pyelonephritis) may result in the development of hypertension and its sequelæ. But in regard to essential hypertension the evidence is as yet inconclusive. Against a renal ætiology, one may quote the following: In the rat experiments, no vascular disease is observed in the clamped kidney; in patients with malignant hypertension minimal vascular damage is seen in the early stages, and severe later; severe bilateral kidney disease can occur without any hypertension. If arteriosclerosis is the result of hypertension, it cannot be convincingly put forward as a cause. It is possible of course that the mechanism of the production of essential hypertension is renal ischæmia, but if so it seems more probable that this is at first functional, being due to some extrarenal factor, and is only later aggravated by renal arteriosclerosis.

In regard to treatment of hypertension, particularly from the surgical aspect, I would emphasize certain points. There can be no doubt that a careful search for unilateral kidney disease should always be made, especially in young patients—though of course the condition is rare. The results of nephrectomy in such patients may be miraculous, though the outcome must be dependent upon whether or no secondary vascular changes have occurred in the sound kidney. As this must often be uncertain, disappointments will occur.

Apart from this very small group, our main concern will be with the very large group of essential or primary hypertension. Here I think it is of first importance to make an accurate diagnosis of the several disorders which have so much in common in their later stages. I refer to the hotch-potch of conditions which masquerades under the designation of "chronic interstitial nephritis". This may include the late stages of Bright's disease, malignant hypertension, benign hypertension, chronic pyelonephritis, and late-stage pregnancy kidneys. Particularly important is the separation of benign and malignant hypertension. Further, a period of careful observation of symptoms, blood-pressure readings, optic fundi, and renal function, is essential.

Until an effective therapy is introduced, it is probably true to say that the majority of patients with benign hypertension are better without treatment unless the state of the heart demands it. Only too often, excessive zeal in treatment of these cases results in a state of blood-pressure consciousness with its train of functional symptoms.

In my experience, the results of denervation operations have been disappointing; and certainly I have never observed results comparable to those claimed at the last International Surgical Congress in Brussels. All observers agree that symptomatic improvement occurs much more frequently than any *permanent* fall in the blood-pressure, and I feel that such symptoms may be functional or may be the result of the enforced rest.

It therefore seems to me that surgery will tend in future to hold a lesser place in the treatment of hypertension, and that a more probable solution lies in the experimental work on pressor substances—though as yet this has not reached therapeutic application.

Finally I should like again to stress the importance of the careful selection of cases, their adequate assessment before treatment is begun and the realization of the benign symptomless course pursued by so many patients with essential hypertension.

Mr. A. Dickson Wright: A special filip to the aetiological study of hypertension was given when it was first discovered by Butler that the removal of a solitary surgically-diseased kidney could dramatically end a high blood-pressure syndrome indistinguishable from the classical type arising idiopathically or secondary to medical disease of the kidney. It was felt that the diseased kidney was distilling some subtle high pressure poison and if that could be discovered and countered another scourge of civilization could be satisfactorily dealt with.

So far the work proceeds with indefinite results, various renins, nephrotonins and tubulins have been described, but so far conviction is lacking.

The enthusiasm arising from the discovery of the hyperpiesis produced by surgical disease of the kidney was tempered and now even seems to be dying away when it was found that 70% of such cases were not benefited by removal of the diseased kidney. Again it was observed that patients with surgical diseases of the kidney were no more afflicted with high pressure than the general public. Pathologically too it was observed that these hypertensive surgical kidneys were the seat of the arteriolar sclerosis found in the kidneys of Goldblatt's experimental dogs and the ordinary hypertensive case. It was therefore presupposed that the surgical disease of the pelvis had excited this arteriolar disease in the parenchyma, high pressure resulted, and this in its turn produced arteriolar disease in the sound kidney. Therefore early removal of the diseased kidney is indicated and if removal produces no result *qua* hypertension the fault is due to the late arrival of the surgeon on the scene and the other medically-diseased kidney continues the mischief. If the kidney of the experimental rat is wrapped up in cellophane like a bon-bon in two weeks hypertension has become established. Removal of the cellophaned kidney does not cure the condition, and the other kidney at post-mortem is found to have the same histological picture as the wrapped kidney previously removed, viz. arteriolar sclerosis.

It has been felt that the power that keeps the kidney working is the pulse pressure, and arteriolar sclerosis prevents this pulse reaching the glomeruli and keeping them pumping.

The enthusiastic search for the surgical kidney in hypertensive subjects has led us into some errors which may on occasions be serious and even endanger the life of the patient.

(1) Pyelography has been overinterpreted and minor variations and kinks have been given exaggerated importance so that in one series 71 out of 178 hypertensives were found to have abnormal pyelograms (Schroeder and Steele). The mere burying of the pelvis in the body of the kidney previously only regarded as the curse of the lithotomist has now been cited as an abnormality causing hypertension by Ravich.

(2) Kidneys may be extirpated on the basis of minor pathology to cure hypertension and nothing results, and the patient has lost a good kidney and is left to fight a largely renal disease with only one kidney, a sad state of affairs. So it must now be held that nephrectomy is not indicated unless the kidney concerned has practically no function left or nephrectomy is indicated *per se*. In each case the operation of splanchnic and lumbar sympathectomy and possibly adrenalectomy should be done there and then because if the patient falls into the 70% who are unaffected by nephrectomy one has at any rate done something else for his hypertension and he requires only one operation more to complete the treatment on the other side.

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## Section of Radiology

President—F. M. ALLCHIN, M.B.

[March 19, 1943]

### The Chest Clinician's Viewpoint of Radiographs of the Chest

By GEOFFREY S. TODD, M.B., Ch.M., F.R.C.P.

In the treatment of the various types of diseases of the chest, the clinician has come to depend upon X-rays more and more of late years. However, the X-ray alone, although of the greatest value, cannot guide the future of the case without the experience of the chest clinician.

(1) *Primary tuberculous effusion*.—The first X-ray will only show a fluid opacity in either pleura. The experience of the physician after sifting the history, plus the removal of a specimen for examination and culture will help a great deal. It is, however, in the future course of this disease that radiology plays its big part. It is important to take X-rays at intervals of at least two weeks in order to watch the progress of the case. If the effusion shows signs of being absorbed the X-ray will be of inestimable value when the lung has three-quarters re-expanded. At this time it can be demonstrated whether or not any disease is present in the underlying lung tissue. If it is present a decision to establish an artificial pneumothorax can be reached. Too often, primary tuberculous pleurisy is allowed to continue its course without X-rays and too late, after complete re-expansion, disease of the parenchyma is noticed.

(2) *Infected effusions*.—These are many and varied. In the early stages of streptococcal and staphylococcal effusions, X-rays are of value in showing whether repeated aspirations are localizing the empyema and thus making the future treatment easier to carry out. Also in those cases which are loculated from the commencement antero-posterior and lateral X-rays will greatly help in giving to the physician the clue as to the best position for aspiration. Effusions following lobectomy, removal of tumours: X-rays are of the greatest value here also, especially lateral ones showing the rate of re-expansion of the underlying lung and also the best position for aspiration on each occasion. X-rays must be repeated before each aspiration if the case is complicated.

*Tuberculosis of parenchyma*.—The use of X-rays is of the utmost importance. They should be taken on admission of the patient and once a month during treatment. It is by the change in the appearance of X-rays that the physician is enabled to form his opinion, completed by the clinical findings, of the improvement taking place and the rationale of increasing the amount of activity of the patient. During the treatment, should a patient run a sudden temperature with no clinical signs, it is of the utmost importance to procure an X-ray at once. Often a spread will be detected, and long and arduous treatment prevented by return to bed until such time as the opacity has cleared.

*Non-tubercular tumours*.—X-rays are of great value in the localization and diagnosis. If a tumour is noticed in X-rays the physician will at once attempt the accurate diagnosis of the type of tumour. Antero-posterior and lateral X-rays are essential (*dermoid lying*



(3) The kidney exposed at the first splanchnic resection may be found to be grossly diseased and although pyelography had been normal one might be tempted (a) to remove it there and then; (b) to refrain from splanchnic resection on account of the gross renal pathology; (c) to go back and remove the diseased kidney later if sympathetic surgery fails.

An instructive case, illustrating (a) and (c) might be mentioned.

A young woman of 26 had a severe eclampsia with her third child and was left with malignant hypertension as a result. She was confined to bed because of her encephalopathy, and her future looked very black indeed as her course was steadily downhill in spite of all treatment.

At her first sympathectomy the kidney was found to be granular with a surface like a raspberry. It was agreed then with Dr. Geoffrey Evans that the first kidney should come out later if bilateral sympathectomy was a failure.

At the second sympathectomy the other kidney looked completely normal, but carrying out my usual rule I did a biopsy as I had done with the grossly diseased kidney, and the sections were indistinguishable; both showed gross renal pathology. This illustrates the value of biopsy in these cases. If this case had not been a complete success now of four years' standing I might have made a serious error in removing the obviously diseased kidney.

A case illustrating point (b) was of a woman aged 41 suffering from hypertensive encephalopathy of the worst type. The usual search for contra-indication fortunately did not disclose the polycystic kidneys discovered at operation. In spite of this I did a splanchnic and lumbar sympathectomy. Great improvement resulted so the other side was done two weeks later and this case, alive and well now after six years, is a constant reminder to me of the evils of contra-indications and preconceived ideas.

Another interesting case is worthy of record. It was a young woman of 26 whose mother had died from hypertension secondary to polycystic kidneys. From her youth she had suffered from chronic intractable coluria and gravel and Mr. Terence Millin had followed pyelographically the gradual destruction of one of her kidneys by atrophic pyelonephritis until at 26 it was functionless and about the size of a dried fig. As the kidney had shrunk so had her blood-pressure risen and she seemed a classical Butler's type of case. At operation the tiny kidney was found to be polycystic and Professor Newcomb confirmed this as a congenital and not an acquired polycystic condition. Sympathectomy done at this time produced a satisfactory fall in blood-pressure but her condition now, a year later, seems hopeless with a palpable remaining kidney, dirty smelly urine and a pressure near 200 mm.Hg.

To sum up: (a) The importance of the surgical kidney in hypertension should be written down rather than up.

(b) Never fail to make a biopsy of the renal parenchyma in hypertension while the kidney is exposed for splanchnicectomy.

(c) The sympathetic nerves should be divided at the same time as the kidney is removed when nephrectomy is done for renal disease in the presence of hypertension.

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*Non-tubercular tumours*.—X-rays are of great value in the localization and diagnosis. If a tumour is noticed in X-rays the physician will at once attempt the accurate diagnosis of the type of tumour. Antero-posterior and lateral X-rays are essential (*dermoid lying*

*anterior, fibroma posterior*). But before diagnosis can be made as to whether the tumour is intrapulmonary or extrapulmonary it is necessary to carry out a diagnostic artificial pneumothorax and then to take antero-posterior and lateral X-rays once again, to determine the operative procedures that should follow.

*Hæmothorax*.—This complication in injuries caused by bombing has been of frequent occurrence in this war. X-rays should be taken at frequent intervals to show progress of treatment and also if hæmothorax is loculated, they will show best position to select for aspiration. It is important to mention that when X-rays only show a slight opacity just above the diaphragm, there may be half a pint of fluid present and one must never say "don't aspirate" in cases showing the above findings because, if infection is to be prevented, it is essential to keep the pleura as dry as possible. This can only be done by repeated aspirations. Before each aspiration radiographs, by portable X-ray if necessary, should be taken.

*Bronchiectasis*.—Lipiodol X-rays are of importance in diagnosis and treatment, especially in unexplained hæmoptyses and in patients with a large amount of purulent sputum. Of course these tests would not be carried out until tuberculosis had been excluded.

*Carcinoma of lung*.—X-ray examination is essential for early diagnosis. It is not always easy to interpret X-rays of early carcinoma but the physician when in doubt should call in a surgeon for bronchoscopy and biopsy of tumour of affected bronchus if present. At the present time a considerable number of cases of carcinoma of bronchus can be given a new lease of life by pneumonectomy.

*Use of X-rays after drainage of fluid by rib resection*.—It is important to take pictures at frequent intervals following this procedure as quite often the lung will re-expand unequally and pockets will form in the pleural space. X-rays are of great value in finding these pockets at the earliest moment and thus enabling their appropriate treatment to be carried out.

*Tomography*.—In late years this has come into great use, though one must be careful in interpreting the shadows shown. It can show small tumours in position in portions of the bronchial tree, it can also show occasionally an unsuspected cavity in a lung in which it was thought there was nothing but infiltration.

## The Ætiology of Erythema Nodosum. [Abstract]

By PETER KERLEY, M.D.

Most investigations on this disease have been carried out on children. The following observations are based on a study of 37 adult cases with an average age of 21. In the majority of cases there was a prodromal stage varying from three to ten days with malaise and anorexia. The acute stage began with fever between 99 and 101° F. and the nodose rash appeared on the shins or forearms or both, twenty-four to forty-eight hours later. Half had coryza and pharyngitis with cough and half had swollen painful joints. Five cases had enlarged cervical glands and one enlarged axillary glands. Blood examinations showed no abnormality except a high erythrocyte sedimentation rate during the febrile stage. Approximately half of the patients felt quite well after fourteen to twenty-one days while the remainder complained of fatigue for from three to four months. Three patients complained of a feeling of constriction in the chest. Serial radiographic studies and tomography revealed gross intrathoracic changes in 28 cases. These changes consisted of massive enlargement of the bronchial glands with or without changes in the lung parenchyma. The lung disease was of two types: (a) reticulation due to lymphatic obstruction, and (b) nodules between 2 and 5 mm. in size distributed in a segment, a lobe or through the whole of both lungs. One girl developed left-sided effusion and another bilateral pleural effusion. The glands and pulmonary infiltration can appear and disappear in a few weeks. The frequency of glandular enlargement in erythema nodosum has been noted by many workers but little attention has been given to the pulmonary lesions which are usually diagnosed as tuberculosis.

The most widely held theory is that erythema nodosum is an allergic manifestation which can be produced by many bacterial and chemical toxins. In this country tuberculosis and streptococcal infections are thought to be the most frequent causes. Certain epidemiological factors which are against the allergic theory are discussed in detail. These

factors are: (a) a racial susceptibility, (b) a seasonal incidence, (c) occurrence of the disease in epidemics, and (d) limitation of the disease to certain age-groups.

A list of all the diseases in which erythema nodosum has been described is given and the findings in the cases under discussion checked with these. All aetiological factors could be excluded except tuberculosis, Boeck's sarcoidosis and streptococcal infection.

The arguments for and against tuberculosis are considered in detail. In four of the cases there was the characteristic appearance of a calcified primary complex. This is held to exclude primary tuberculosis as a factor. Follow-up studies of the cases showed that none developed post-primary tuberculosis. Bacteriology and guinea-pig inoculations of pleural fluid were negative for tuberculosis. Corelli's work on pleural nodes similar to those on the shins is quoted. Mantoux testing and examination of nodes excised from the shins were inconclusive. None of the patients had been in contact with a known case of tuberculosis.

The findings were more conclusive when checked against sarcoidosis. The clinical and radiological findings are identical—extensive visceral disease without physical signs and fatigue as the main or only symptom. Two patients developed iritis suggestive of sarcoidosis and in two others excised skin lesions showed the characteristic histological features of sarcoid disease. The literature on Boeck's sarcoidosis shows that approximately 25% of cases give a history of erythema nodosum.

Streptococcal infection could be excluded in all but one case. This patient's fever responded dramatically to sulphapyridine but although he was clinically cured his mediastinal glands continued to enlarge and he subsequently developed an iritis. It is suggested that there is a common factor in all cases of erythema nodosum and that the rash in adults in this country is most often a symptom of sarcoidosis. The radiological demonstration of symptomless bronchial glands and pulmonary infiltration is not an indication for sanatorium treatment.

[This paper is published *in extenso* in *British Journal of Radiology*, 16, 199.]

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and dermatologist realizes that optimum and economic dosage has neither been achieved nor is a matter of common agreement.

Much is to be said for an arrangement by which the dermatologist should, unless specially trained, limit his prescriptions to setting down clearly dosage in r units over a specifically spaced period. Reference to filtration should be made where departure from an accepted constant is indicated.

The doses for other common disabilities are agreed on after mutual contact. The therapist must accept responsibility as to how he ensures an even dosage over the field to be treated.

Malignant disease is normally handed without restriction to the radiologist—it is his field rather than that of the dermatologist.

*Future outlook.*—It should be an integral part of dermatological training to acquire elementary knowledge not only of the possible utilization of X-ray and radio-active substances, but also of the many physical problems with which the radiotherapist is familiar in controlling his treatment.

The radiologist might rationally be asked to receive elementary instruction in the pathology and aetiology of commoner skin disabilities coming under his care for treatment.

Team-work in hospital clinics is easily attained. The dermatologist can realize his own limitations and the radiotherapist understand that his own assistance is only an adjuvant to other therapeutic measures for which his dermatological colleague is primarily responsible. The therapist should envisage the natural desire of the physician to watch the progress of his case during therapy as well as after it.

It would appear desirable that every centre undertaking regular treatment of diseases of the skin attaches to itself a radiologist with experience of radium as well as X-ray therapy. Regular visits from a physicist must be insisted on. He should be responsible for calibration, screening of rooms, and checking of applicators and filters.

Frequent discussion is invaluable and an agreed constant dosage for most common disabilities can be arrived at. Such dose is expressed by the dermatologist in r units with spacing of dates only. Method of administering the ordered dose is the duty of the therapist.

Close collaboration may not always be possible in private practice. It should be accepted that the dermatologist may prefer to be responsible for his own cases since supervision during, rather than after, radiotherapy is essential. He is probably wise if he installs a shock-proof outfit with a small number of applicators, a constant voltage, constant filtration and fixed rate of output. A stabilizer and regular visits from a physicist to check up tabulations are obvious safety measures. After the advice of his radiotherapeutic colleague as to lay-out he soon has confidence in, and knowledge of, the capabilities and the limitations of his apparatus. Cases better dealt with by others who have a wider range of applicators he should refuse to treat.

Without modern stable apparatus the dermatologist should refer his private cases to someone experienced in this form of therapy. He should restrict duration of treatment and insist on the patient's return if early relief is not experienced.

**Dr. N. S. Finzi:** Dermatologists to-day should endeavour to become familiar with current radiotherapeutic practice. Since about 1928 most radiotherapists have much reduced their dosage in inflammatory conditions. This has brought about not only an improvement in results, but also an avoidance of late deleterious after-effects, even when the treatment is carried on for long periods. Those dermatologists who still use bigger doses for inflammatory lesions should try the effect of smaller doses. This does not apply to rodent ulcers, malignant conditions or angioma. Notation must of course be in roentgens and  $D_{10}$ , the surface dose and not  $D$ , the air dose should be specified. Contact therapy, i.e. a Focal Skin Distance of 5 to 10 cm. is going to be of much greater value to the dermatologist than to the pure radiotherapist in dealing with localized lesions either innocent or malignant. The question of wavelength and filtration will have to be gone into clinically. I know the physicists recommend the longer wavelengths and no filtration, but this is quite at variance with my personal experience. A radiologist friend who, owing to a breakdown in his surface therapy apparatus, was forced to use higher voltages and filtered radiations for skin treatments found that the cases seemed to do better. These penetrating radiations should therefore also be tried by dermatologists. It must, however, be remembered that the number of roentgens must be greater to get the same biological effect as with the less penetrating radiation. For instance at 90 kV. and no filter the weekly dose in inflammatory conditions will be 25 to 45 r but with 130 kV. and a 5 mm. al filter it will be 35 to 60 r. With very long wavelengths, Buck's "grenz rays", the dose has to be incredibly higher, but I have no experience of these. With

JOINT DISCUSSION No. 6

## Sections of Radiology and Dermatology

[April 16, 1943]

Chairman—M. H. JUPE, M.R.C.S., L.R.C.P., D.M.R.E.

### DISCUSSION ON THE FUTURE OF RADIOTHERAPY IN DERMATOLOGY

Dr. P. B. Mumford, opening the discussion, deplored the lack of research on the part of dermatologists in co-operation with radiological colleagues. Description of the arrangements existing in Manchester was presented.

He went on to say: Attempts have been made during the past year to establish a service which it is hoped will provide treatment for a large number of skin disabilities of widely variant type. The central teaching centre is the Royal Infirmary. The Radium Institute and the Skin Hospital have their own particular fields of work. Sharing of apparatus and medical services is of the fullest—free transfer of patients occurs and each of three main hospitals realizes not only its limitations but its particular duties. Research, shared by dermatologists and radiologists on an equal basis, is now undertaken. Private practice is not interfered with but tends as a result of mutual research to be of greater efficiency.

Prior to the inception of this scheme the majority of skin cases, including nævi and carcinomata, were treated independently in Manchester by the Skin Hospital and the Christie Hospital and the Royal Infirmary. The first two are probably the largest institutes of their kind in Great Britain. The present annual attendance at the Skin Hospital is over 100,000 including 20,000 new cases. The average number of X-ray treatments per annum is above 2,000. Treatments were, in the past, given by a radiographer and expressed in Sabouraud units with no comment as to other physical factors. Results were good, rarely was harm noted. Little thought was given to the value of varied dosage. Advance in knowledge and research was negligible. A physicist was not retained. Physicians prescribed and examined radiated cases on conclusion of each short course of therapy.

The Royal Infirmary treated a relatively small number of cases but for the great part acted as an independent unit. An honorary radiotherapist, also on the staff of the Radium Institute, was able to deal with dermatological problems.

The Radium Institute with an annual attendance of over 3,000 new cases included skin cases (forming 15% of the total). The Institute had no dermatologist and little or no co-operative contact with the neighbouring Skin Hospital existed. Transfer of cases was undertaken in a very small proportion of instances.

Initial steps were taken by the Radium Institute who appointed two consultant dermatologists and enlisted the help of the Skin Hospital histologist. The Skin Hospital invited the Director of the Radium Institute to undertake general charge of its X-ray department. From then onwards there has been a close liaison between both institutions. The Royal Infirmary co-operates and acts on similar lines.

Prescription of dosage is entirely the dermatologist's responsibility. Where no definite specification is made the radiotherapist acts as he thinks wisest. He is responsible for entering exact details of the treatment he has given on a slip inserted in the out-patient book of every case attending his department. He refers the patient on completion of treatment to the honorary physician in charge. Differences in opinion rarely arise and in the few cases where either party wishes to offer criticism personal approach immediately solves the problem.

In the malignant field it is tacitly understood that if a physician at the Skin Hospital wishes to prescribe a particular dose then such treatment is carried out by the radiotherapist.

It is to be hoped that in future years joint reports will be published on the response of the common disabilities, e.g. cavernous nævi, carcinomata, pruritus ani et vulvæ. Several hundred of these cases require correlation before comment is offered. Every radiologist

But, ordinarily, he cannot bring into the combine a sufficient knowledge of skin disease and of its pathology, to take the direct clinical responsibility himself. In one limited field only—that of malignant disease—because of his much wider experience of this disease in other parts of the body, he can bring special knowledge. The totally different principles of treatment and the need for years of follow-up in malignant disease, make it more expedient that skin cancer should for treatment purposes count as cancer, not as skin.

Dr. Mumford has described the collaborative experiment which we have started in Manchester. Here is what we have done to re-organize the X-ray department of the Manchester Skin Hospital since taking over responsibility for its general administration:

(1) Most of the dermatologists have agreed that in malignant disease of the skin, the radiotherapist becomes totally responsible for the treatment. He sees every case and marks it for treatment. For non-malignant disease, the prescription is given by the dermatologist and the treatment carried out without the radiotherapist necessarily seeing the case itself. In this field his responsibility is for the main lines on which the department is run.

(2) We have eliminated certain potential sources of error, such as crude time clocks, removable filters, faulty techniques of setting up, and the like—and have added a qualified (M.S.R.) X-ray technician to the department staff.

(3) All the plants have been recalibrated to run at standardized output rates and settings with only two voltages in use—70 kV. and 140 kV.—and at fixed output rates of

for the long applicators	... 60 r per min. (i.e. 1 r per second)
for the short applicators	... 150 r per min.

To do this the whole of the applicators in the department were first calibrated for actual surface output with backscatter. Then by judicious use of shortening and lengthening, or by the insertion of thin permanent filters, the various applicators of the department were equalized, so that for all tubes and both kV.s in use, the output rates were constant as stated.

(4) We have so far just made a start on a possibly very useful development, the compilation of what I might call surface isodose charts, to permit fusion of multiple fields over curved areas, following and extending the classical example of the famous Adamson technique.

(5) We have, with little difficulty, persuaded our colleagues to think and prescribe in terms of roentgens of dosage and forget about pastilles, erythemas and other archaic concepts and we have, I think, given them the assurance that roentgens really have a meaning. All the features of a treatment are then summed up in such terms as "50 r per day for two weeks", or "100 r weekly over six weeks" or, equally safely, 1,000 r or 2,000 r in one exposure.

(6) Lastly, and perhaps most valuable of all, we have planned as the joint task of dermatologist and radiotherapist, to take one disease at a time and submit it to close experimental study in an effort to contrast various techniques under controlled conditions. So slowly, perhaps over a number of years, we hope to evolve a series of what may later become standardized techniques.

**Dr. A. M. H. Gray:** It is clear now that the whole future of medicine depends on teamwork, and especially so in dermatology. I agree with the previous speakers that from the dermatological point of view we want a great deal of help from the radiologist, and I hope the radiologist may feel the same with regard to us. I have no hesitation myself in saying that I think it is our duty as dermatologists to hand over to the radiotherapist all cases of malignant disease of the skin requiring radiotherapy, for that is his province, though I would add that there should be previous consultation between the radiotherapist, the dermatologist, and, if necessary, the surgeon in deciding what the right treatment should be.

**Dr. A. C. Roxburgh:** I can confirm what Dr. Finzi has said about the cordial relations between our two departments at St. Bartholomew's Hospital. I have been led by him to use doses of 50 r rather than 100 r in infections such as sycosis and boils with improved results, though I think that eczema, unless very acute, does better with 100 r.

**Dr. W. N. Goldsmith:** With regard to cancer I agree that the severer forms should be handed over to the radiotherapist, but not multiple superficial carcinomatosis, for which, in my opinion, freezing with CO<sub>2</sub> snow is the best treatment. Little rodent ulcers I prefer to treat by electrodesiccation, as it is more certain than X-rays and the scarring is no more conspicuous.

I agree that simplification of technique in X-ray treatment is most desirable in order to arrive at agreed optimum dosage. I do not think, however, that Dr. Mumford's plan of



very wide fields great care must be exercised not to damage the viscera and not to produce blood changes. This is effected by using short focal skin distance or by tangential irradiation.

In angioma dermatological treatment leaves much to be desired.  $\text{CO}_2$  snow and other caustic measures produce scarring and should never be used unless scarring does not matter. Thrombosing agents also tend to produce scarring. The use of unfiltered radium too has often resulted in scars, as has the too frequent application or overdosage of  $\gamma$ -rays. With correct doses of  $\gamma$ -rays marvellous results can be obtained without scarring, unless the naevus is already ulcerated and the treatment should never be repeated in full doses before six months or preferably a year. The use of minute doses of  $\gamma$ -rays or X-rays to heal spontaneous ulceration in naevi is known only to very few dermatologists and radiologists. Lister has shown that a number of these cases retrogress without treatment, but there are many that do not.

The treatment of malignant skin conditions by radiologists is now in a very satisfactory state. Any dermatologists not fully conversant with the physical data must either acquire this knowledge or leave such cases to the radiologist.

In the future we hope to know more about the causes of skin diseases. Again as we learn more of the way in which the rays act and how to improve their application, rays such as neutrons and other little-used radiations, such as  $\alpha$ -rays, may be more frequently employed.

The realization of the value of smaller doses in inflammatory conditions will certainly result in further extension in the use of radiations.

Naevi will no longer be scarred by caustic treatments, but will be persuaded to retrogress gently, possibly with the help of radium.

**Dr. Arthur Burrows:** As a rule very few difficulties occur between the dermatologist and the radiotherapist.

The radiotherapist is struggling for the recognition of his subject as an entity while the dermatologist wants to keep his specialty as broad and interesting as possible. Moreover, it must be remembered that the loss of the treatment of rodent ulcers will not only remove an interesting aspect of the dermatologist's practice but will definitely reduce his income. Many radiologists are on a salary basis, but the dermatologist has to earn his living by practice.

A specialty may be very limited. For example some radiotherapists know little about radium treatment while a dermatologist may be better acquainted with it so far as skin diseases are concerned.

As, however, the treatment of the patient comes first, it is obvious that some method has to be devised by which the dermatologist and radiologist can work in partnership to produce the best possible results in the form of therapy in which they are both interested.

**Dr. Ralston Paterson:** There is no doubt that in certain diseases of the skin X-rays can be either the best, or one of the best, methods of treatment available. Nothing like full use is being made of this valuable therapeutic agent at the present time.

Failure to get full value from what ought to be a potent weapon is, I think, due to failure of collaboration between dermatologist and radiologist. McKee's textbook on "X-rays in Skin Disease" set the standard of treatment in 1927 and it has not altered much since then.

In contrast, it is safe to say that the advancement in the production and utilization of X-rays in the collateral field of cancer therapy has been outstanding.

This increased knowledge must now be brought into use in the less vital but equally important—because so very much larger—field of dermatology. This calls for collaboration of a new order between dermatologists and radiologists.

The dermatologist brings his knowledge of the clinical features of skin disease and is in a position to contrast radiotherapeutic methods with other methods available to him. He should discard out-dated conceptions as to voltage and filters; he can then start to think clearly in terms of dosage of roentgens of radiation—and prescribe the treatment. In this way he will be able to study the effects of different dosages at definite intervals for each disease. He must trust to his radiologist colleague the responsibility of seeing that such doses are delivered accurately. Once the dermatologist finds that roentgens of radiation are nearly as exact a quantity as, say, grains of zinc oxide, he can experiment in reasonable safety with methods of treatment—a thing which heretofore he has never been able to do—with the result that he has generally tended to under-dosage.

The radiotherapist can bring into the combine a knowledge of modern X-ray plant, of modern dosimetry and of the precautions necessary for the safety of patients and staff.

## Section of Psychiatry

President—J. BRANDER, M.D.

[May 11, 1943]

### Amnesia in Altered States of Consciousness

By ANDREW PATERSON, M.A., M.D. Edin., D.Psych.

(From the Brain Injuries Unit, Edinburgh)

It may be of interest to consider a group of cases in which episodes have occurred having many of the characteristics of fully conscious behaviour but for which there is no subsequent recall.

What constitutes fully conscious behaviour? Sir Charles Sherrington (1940) writes: "Each of us at any moment of the waking day is a whole bundle of acts simultaneously proceeding. Among that bundle is a main or focal one which our conventional viewpoint stresses as the one which at the moment we are doing. . . . We are therefore at any moment a pattern of activity doing a single pattern of pieces all subordinate to one key piece."

I suggest that where the "key piece", in Sherrington's sense, is properly adapted both to the perceptual situation calling it forth and to the balance of emotion and purpose in the individual, the behaviour may be said to be fully conscious.

Such behaviour requires adjustment not only to the immediately perceived setting and what has preceded it but also to a wider background of past experience. Without this continuity of experience which memory provides, behaviour would lack continuity, and episodes altogether isolated from the general experience may take place; these cannot usually be recalled.

Emotional and conative tendencies of the individual also assist in determining full consciousness. These can be regarded as internal stimuli to which the cognitive abilities are harnessed and normally maintain a balance which enables the various needs of the organism—psycho-biological and social—to be satisfied harmoniously. These two sets of factors—cognitive and dynamic—combine to maintain and direct adaptive behaviour.

In the ordinary hypnotic state, the perceptual field may be artificially restricted and some of its features inhibited by the operator. Experiences become isolated and the command of the hypnotist takes on an imperious aspect. Thus, when so directed, a hypnotized patient may proceed to shut a door which is already closed. The latter fact is ignored selectively in accordance with the command. Here then is an act of focal behaviour which superficially suggests fully conscious activity. It has an object or end in view, attention appears to be fully occupied with it, and appropriate means are taken to carry it out. But the act has no continuity with the past or future experience of the patient and the aim has no significance apart from its mere performance.

Such restricted experience in deep hypnosis cannot be recalled later in normal consciousness. For its recall a similar setting or orientation is necessary. An analogy in ordinary experience occurs when we fail to recognize a familiar face if the perceptual setting is different from that in which we are accustomed to see it.

The difficulty and apparent resistance to recall of hypnotic experiences cannot be regarded as an escape mechanism. The amnesia serves no immediately useful purpose. It has many of the characteristics of the fugue state but there is no advantage to be gained for the patient by forgetting. It is widely held that wherever there is forgetting of experiences, in the absence of a gross retention defect on an organic basis, the patient has a witting or unwitting desire to forget. The case of post-hypnotic amnesia should help to dispel this notion.

An hypnotic state is commonly called a dissociated state and I shall use this term to cover all cases of restricted experience for which there is subsequent amnesia, irrespective of whether the amnesia is due to hypnotic, emotional or organic causes. I shall try to show that an organic retention defect may lead to the isolation of experiences in such a way as to render them inaccessible to ordinary recall.

In cases of head injury, after normal consciousness has returned, episodes of isolated behaviour may occur with subsequent amnesia which are closely analogous to the restricted, dissociated behaviour mentioned in connexion with hypnosis.

using only one kilovoltage adequately covers all dermatological conditions, whether affecting mainly epidermis or, on the other hand, the sweat glands or hair papillae in the subcutis. Dr. Paterson's 2 kilovoltages viz. 70 kV. and 140 kV. appear a reasonable compromise.

I cannot follow Dr. Finzi's rather general statement that with higher kilovoltages a higher number of roentgens are required. Since the r dosage represents the intensity of action on air at the surface of the skin (not the total energy emitted by the tube), it must follow that if one gives 500 r of hard rays the total effect on the superficial layers of the skin (as well as the deeper layers) must be greater (rather than less) than if one gives 500 r of soft rays; for with the harder rays the direct surface dose is the same and there is in addition the indirect effect of X-ray action on the deeper layers. It may well be that hard rays produce less erythema, but this is no guide to total biological effect on the whole thickness of skin or to the prospects of late damage. We are familiar with the most intense erythema produced by ultraviolet rays and grenz rays, which is not followed by any atrophy. It is the result of damage to the epidermis and depends on the intact or relatively intact dermis which reacts to the products of cell-damage reaching it from the epidermis. Much at least of the erythema produced by X-rays must be brought about in the same way, and if the same dose of hard rays produces less erythema it is perhaps because, while doing the same amount of damage (if not more) to the epidermis, it is at the same time damaging the cutis so that it cannot react so vigorously. I cannot therefore concur in the advice we are sometimes given that for safety we dermatologists should only use the hard end of our scale. The excellent results that can be obtained with grenz rays with complete safety from serious damage are enough to negate this advice. I do not find, as Dr. Finzi says, that enormously higher doses are needed with grenz rays. For such conditions as eczema I mostly give only about 150 r at 15 cm. with 11 kV.

**Dr. H. C. Semon:** Many important issues have been raised by members of both Sections, and it is very evident that there is ample scope for more than one combined meeting in the near future.

**Dr. Ffrangcon Roberts:** The dermatologist and the radiologist should each have complete freedom to develop his work unfettered by the artificial barriers of departmentalism. While progress is best assured by co-operation between the two, the dermatologist should be free to carry out radiotherapy if he wishes and the radiotherapist should be free to accept cases direct from general practitioners and he should not confine his interest merely to technique.

It has been suggested that the radiotherapist should carry out exactly the prescription given by the dermatologist, and should not use his own judgment on the case. This is not true co-operation but is tantamount to reducing the radiotherapist to the status of technician, a situation which no self-respecting radiotherapist can accept. The radiotherapist should be given complete freedom in regard to dosage if only for the reason that he is legally responsible.

**Dr. N. S. Finzi:** As to the question of dosage, raised by Dr. Goldsmith, I think that most radiologists now are agreed that the physical dosage, expressed in roentgens, does not actually correspond with the biological dosage. For instance, in radium treatment of the skin about double the number of roentgens would have to be used in order to get the same effect as with X-rays of medium wavelength, the reason probably being that the rays are less stopped or slowed in the tissues. The effect probably depends on the fact that fewer ionizations are started in the skin when a more penetrating radiation is used. It is quite obvious clinically that there are wholly different biological effects if a wide enough range is taken.

Another question, also asked by Dr. Goldsmith, concerns electrodesiccation in the treatment of rodent ulcer. In the United States I saw the case of a man who had had a record number of rodent ulcers and epitheliomata, he had had 97. I witnessed the electrodesiccation of 15 of them, and evidently it can be a quite useful method.

**Dr. H. G. Adamson and Colonel Boulton Myles** also spoke.

automatism". "It is convenient", he writes, "to have one name for all kinds of doings after epileptic fits from slight vagaries up to homicidal actions. Hence I use the term 'mental automatism'. I say 'mental' as the doings are probably external signs of epileptic dreams". Neurological textbooks as a rule restrict the term automatism to epileptic phenomena. Most psychiatrists, however, take a wider conception and Henderson and Gillespie (1927), for example, consider that automatism may be local or general, and if general that the concept should include somnambulisms and fugues.

An interesting example of automatism in Jackson's sense of the term recently came to our notice. A young London University graduate received a severe head injury with gross cerebral contusion resulting in marked atrophy of the right frontal lobe. He developed a post-traumatic epilepsy of particular severity frequently leading to a status epilepticus. Large amounts of drugs modified these attacks but he had in their place episodes of automatic behaviour. When walking along a street in Sheffield he would suddenly experience a strong paramnesia that he was back as a student in London. He would next find himself on a bus perhaps a mile from where he had boarded it. At this point he would have a confused feeling that he was in London and would have to inquire as to his whereabouts. He had no recollection of actually boarding the bus. It appeared that as an undergraduate he had made a regular daily bus journey to college. In his confused state he believed that he was making the same journey, although of course he was really in Sheffield. The mechanism of automatism would thus appear to depend on a sudden failure of the processes that maintain normal consciousness. The outcome is a restriction of consciousness with failure—in Lewis's (1932) term—to actualize the present. The similarity of this behaviour to that set up artificially by the hypnotist's command cannot be overlooked. For the period in the bus this man had no recall although his behaviour appeared unexceptionable. This post-traumatic automatism resembles closely the isolated episodes of maladaptive behaviour I described in the earlier cases.

The most common type of amnesic episode is associated with emotional stress where there is no question of an organic lesion. When it involves wandering the episode is generally known as a fugue and the term is best confined to this meaning (Stengel, 1943). But amnesic states developed on an emotional basis, though not involving overt wandering, resemble the fugue in being dissociated from the continuity of normal conduct.

A young van driver, within the course of a week, had had three relatively short periods of amnesia ranging from half to one hour in duration. These attacks had occurred while he was driving his van and on each occasion he found himself some distance off his proper route with no recollection of how he came to be there. Epilepsy was considered and rejected. Investigation showed that the patient had been brought up strictly and without affection by a stepmother who compared him unfavourably with her own son. Brow-beaten and thwarted, he satisfied his early ambitions by recourse to fantasy. He was bright and intelligent but had been obliged to leave school at 14 and start to work. He ran away to sea and later joined the Army from which he secured his discharge. He settled down to civil life with an overwhelming ambition to become a professional footballer. In an important trial match his team was hopelessly beaten and his hope and pride dashed in the eyes of his friends. Three days later he had his first attack of amnesia. He came to himself to find that he had driven his van two miles out of town and was quite unaware how he had come to this spot. He was intensely pre-occupied with his disappointments and depressed at the vanishing chances of realizing his ambitions.

In this ill-knit personality the intense emotional pre-occupation with his misfortune had allowed him to drive his van for two miles in what appeared to be an entirely automatic manner and he was unable to account for the aberration. But from this moment onwards the failure of recall became for him a symptom explaining his personal shortcomings. In his mood of depression here was a solution to his problems, and two similar episodes were repeated within a week.

The next case illustrates amnesia for a period of dissociated behaviour following a severe emotional trauma. The patient was a healthy man of over-conscientious and sensitive temperament. There was no history of overt neurotic traits. He was driving a heavy truck when it overturned, pinning the occupants beneath it and inflicting fatal injuries on one of them. The driver, our patient, in extreme pain believed that he was dying. He was quickly released and got to his feet apparently uninjured. Seeing his friend horribly mutilated his behaviour suddenly became wild. Oblivious of everyone on the scene, he made no attempt to co-operate in the rescue work but rushed about shouting and tried single-handed to uproot a tree trunk with which to lever up the lorry. His consciousness appeared to be restricted to this one urge to release his friend, but blind to any practical method of carrying it out. So troublesome and obstructive was

A young man aged 23, of average intelligence, sustained a severe closed contusional head injury. He was confused for four days, after which his disorientation and retention defect cleared up fairly rapidly. After fourteen days he was quite well orientated. He knew that he was in hospital and had had a head injury. His retention defect was now relatively slight. Thus he could recall the events of the preceding few days with considerable accuracy. One evening at this time he was seen to emerge from his room completely in the nude apart from a belt. This he was carefully adjusting to his new girth as he walked along the hospital corridor. Asked by a nurse where he was going, he said he was walking home to see his wife. He had apparently discarded his pyjamas but in his desire to get home quickly had ignored the fact that he required clothes. But he decided to take the belt in the pocket of which were his valuables. A few hours later he had no recollection of this episode.

Here is an example of focal behaviour. The patient had a plan to go home to see his wife which he was able to formulate to the nurse. Further, he had taken some of the necessary means to that end. Due to the restriction of his perceptual field, however, he had neglected other essential ones—his clothes, and apparently, selectively also, the fact that his home was a hundred miles away.

His desire to be at home was very considerable but had been held in check against the background of other desires, restrictions and social inhibitions. In the drowsy state in the evening the controlling background was relaxed and the desire for home became isolated and dominant. It can't be compared with the hypnotist's command, but arising from within rather than without.

The minor retention defect in this case reinforced the isolation of the desire to go home. When recent memory is even slightly impaired the wider setting which falls outside what is immediately perceived fails to have its controlling influence. The immediately past acts inconsistently and, when it fails, focal behaviour becomes relatively isolated. This isolation is analogous to the dissociation which takes place in hypnosis. The subsequent failure of recall is a function of this isolation.

A second case of head injury is also instructive. A man aged 42 received a moderately severe contusional head injury. He was unconscious for one hour and confused for two to three hours. During his third day in hospital he was quite well orientated in every sphere. He had some minor neurological signs and a mild retention defect. On the evening of the fourth day in hospital he was observed to get up, put on a dressing-gown, take out his gas mask and put it on. He was not asleep. Looking afraid, he walked down the ward towards a nurse and asked to be guided to the air-raid shelter in spite of the fact that the ward was quiet and there was no air raid. He had no subsequent recollection of the incident. Here again is a piece of directed behaviour, correct in many details, but overlooking important aspects of the true situation. In a state of restricted consciousness his fear of an air raid had become isolated and dominant. It had initiated a train of complicated actions with safety as its immediate objective.

Here again the isolated drive, in this case fear, had a clear history. We discovered that a month prior to the accident the patient had been involved in a severe air raid when visiting a much-bombed city.

Similar amnesic episodes are relatively common in other organic brain conditions. I will give one example to indicate other factors giving rise to the dissociated state.

A man, aged 42, was referred to us on account of an amnesic episode. One evening he had travelled to a near-by village which he knew quite well to make a routine collection of rents. Five hours later he arrived at the first house demanding the rent. The time was now 11.30 p.m. He was observed to be strange in his manner by the irate tenant who persuaded him to go home. In this case, the journey had been made in failing light and the ordinary landmarks did not provide the visual clues which serve to maintain proper orientation. This fact, together with an organic impairment of memory which had hitherto passed unnoticed, brought about a state of disorientation. This disorientation was complete for time of day and partial for place. But despite this the patient carried out, in an inadequate and semi-automatic way, the purpose with which he had originally set out.

This episode was the first sign of general paresis in a healthy man who had been satisfactorily treated eighteen years before. It shows cognitive restriction and also the way in which a restriction of the perceptual field due to black-out conditions reinforces the effects of an organic retention defect. Fatigue, which interferes with remembering in normal persons, may exaggerate a mild memory retention defect. The influence of what is immediately past no longer has its normal controlling effect. The individual is in consequence more strongly predisposed to dissociated behaviour.

Similar phenomena occur in epilepsy, but often in a more dramatic way. They were studied in detail by Hughlings Jackson (1931) who gave them the name of "mental

The use of simple memory tests in psychiatric assessment is by no means novel. A number of tests are in fairly general use, though they have been evolved *ad hoc* without any very adequate definition of their sphere of usefulness. These tests are of four types: (1) Tests demanding *verbatim* reproduction of a short series of disconnected stimuli from immediate memory. An example is the familiar digit test. (2) Tests requiring recall of a small number of unrelated items after a slightly longer interval, as a rule five or ten minutes. An example is the so-called "Name, Address and Flower" test. (3) Tests of substance memory, e.g. recall of the gist of a short story read to or by the patient. Stories adapted for this purpose have found their place in many textbooks of psychiatry. (4) Tests of rote learning such as the paired associate experiment.

Our experience with the first three of these test methods has been unsatisfactory. Let us consider first *the digit test*. Its clinical use is based on the assumption that any condition adversely affecting memory retention restricts the immediate memory span for digits. This assumption is fallacious. In cases of very outspoken organic retention defect, as in Korsakow's psychosis, restriction of immediate memory span is the exception (Wechsler, 1917; MacCurdy, 1928). Indeed an impairment of immediate verbal memory is the rule only in cases of sensory dysphasia (Isserlin, 1923), and here it occurs typically without significant impairment of general memory. Disturbances in digit repetition, as I shall show later, may also be observed in neurotics. As a routine memory test, however, the procedure is practically worthless. The "Name, Address and Flower" test is even less satisfactory. It does not discriminate between organic and functional disorders of memory and the standards of normal performance are decidedly problematical. Tests of *reproducing short stories* are sometimes helpful but notoriously difficult to score and standardize. Patients with very gross organic retention defect are of course unable to give the gist of a short story. But in such cases the impairment is evident enough to the psychiatrist without the help of special tests. In milder amnesic conditions recall of such material may be essentially normal and very little reliance can be placed on the performance as an index of impairment. Tests of rote learning appear to be the only type which give satisfactory results for purposes of routine psychiatric assessment. These tests are also less arbitrary. There is good experimental evidence that the learning of simple test material is virtually impossible in cases with gross organic memory disturbance. Wechsler (1917), following earlier German authors, demonstrated this fact very convincingly in cases of Korsakow's psychosis. We have had occasion to confirm his finding in a wide variety of organic reaction types with conspicuous defect of memory. We argued further that tests of learning may reasonably be expected to give evidence of retention defect in less severe forms of organic impairment. This expectation has been well borne out by our present results.

The standard type of verbal learning test is the paired associate experiment. For various reasons, in part theoretical and in part expedient, we chose instead three simple learning tests. Two are verbal and the third a performance test. The first is a modification of the digit test which can easily be combined with an estimate of memory span. The second involves learning a short sentence by heart under prescribed conditions. The third is a place-learning test devised by Rey (1934). These three tests are brief, easy to apply, and adapted to the needs of routine neuropsychiatric examination.

The digit test forms part of the Bellevue Adult Intelligence Scale (Wechsler, 1939). It is made up of seven pairs of digit groups. The shortest comprises 3 and the longest 9 digits. Our procedure is as follows: First we determine the memory span for digits according to Wechsler's procedure. The former may be defined as the longest sequence of digits the subject is able to recite without error after one reading by the examiner. Secondly, we ascertain the minimal number of repetitions needed to obtain correct recitation of sets of digits exceeding the span. Thus suppose the patient can repeat 7 digits after a single reading but fails on a set of 8 digits. We repeat the latter until a correct response is obtained. The patient throughout attempts a repetition after each reading by the examiner. This procedure is then repeated with a longer sequence of digits. The number of repetitions required for correct response at each step is recorded.

The results of this simple test in cases of severe or moderate organic retention defect are often striking. We commonly find a very marked disparity between the memory span for digits and the number of repetitions required for proper reproduction of longer sequences. I shall give some examples drawn from cases in which a defect of memory was clearly present but by no means immediately evident. The first is a case of frontal lobe tumour tested post-operatively. This patient had a basal digit span of 6 but failed to repeat a sequence of 8 digits correctly with ten consecutive trials. Another case of frontal lobe lesion with a span of 6 digits was unable to learn a sequence of 7 digits with ten consecutive trials. Many cases of post-traumatic intellectual impairment give similar results. One such case with a basal span of 5 digits failed to repeat a

his behaviour that he had to be led away. Following his admission to hospital he took no apparent notice of his environment and constantly muttered that he had killed his friend. The patient was in a semi-stuporous state for several days. On recovery of normal consciousness he was able to recall the accident up to the time of his own extrication from the truck. He also remembered the transient belief that he was dying. He could recall seeing his friend horribly mutilated but he had no recollection whatsoever of what happened after this.

We induced a state of mild narcosis by sodium amytal and he was then able to relate the whole story of his wild behaviour. After recovery from its effects there was complete inability to recall both the original experience and its narration in narco-hypnosis.

This period of abnormal behaviour resembles the automatic dissociated states already described in organic cases. The aetiology is different. Some would see in the forgetting of the traumatic episode in the last case an example of repression. But there are features in his later behaviour other than its mere painfulness preventing recall. The patient was quite distraught after his release from the van. His cognitive activity was isolated and restricted. The emotional drive to release his friend was expressed so grossly that it precluded all reasonable measures of effecting its end. As in other cases described, these states are seldom accessible to normal memory. Only in the restricted setting induced by narcosis could the traumatic episode be reinstated and described. The resemblance between this case and the hypnotic state is obvious.

There are important points of similarity between the different types of dissociated state whatever their aetiology. After acute emotional stress we have seen the same cognitive and emotional isolation of the reaction and proneness to later amnesia as in organic cases.

It may be objected that, in some functional cases at least, the memories apparently lost can be reinstated under suitable conditions and that this is not the case for the organic dissociated states. In the latter cases with true memory impairment we have no method of ascertaining whether the memories involved are recoverable or not. In them the effect of induced narcosis is usually to set up a state of confusion or to intensify an existing confusion. Some authors, however, have claimed that amnesia for relatively short periods, due for instance to alcoholic intoxication, can be cleared up by hypnotic procedures. This suggests that the differences between organic and functional dissociated states may be less profound than is often thought. I believe that a closer study of the behaviour actually displayed in these cases of different aetiology may open the road to a more satisfactory neuropsychiatry of amnesia.

[My thanks are due to Dr. William McAlister, Medical Superintendent of this hospital for access to these cases; they have been studied under the auspices of and with the assistance of the Rockefeller Foundation and University of Edinburgh.]

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## Clinical Tests of Memory Impairment

By O. L. ZANGWILL, M.A.<sup>1</sup>

I WISH to describe some simple test methods for assessing memory defect which we are developing at the Brain Injuries Centre in Edinburgh. These tests are still in an experimental stage and I am not yet able to give data on the accepted statistical scale. But we believe we have progressed far enough to justify an interim report on our findings and to offer these methods for tentative trial in other neuropsychiatric centres.

The purpose of our tests is to provide criteria of what is commonly called organic memory retention defect. In view of the nature of our material, most of the cases so far tested have displayed an impairment of memory on a confirmed organic basis. But our experience with functional cases, limited though it is, suggests that these cases may also exhibit characteristic patterns of impairment. We therefore hope that the tests may prove of assistance in the differential diagnosis of organic and functional disorders of memory.

<sup>1</sup> From the Brain Injuries Unit, Edinburgh, and with the support of the Rockefeller Foundation.

repetitions of the passage without success. It follows that whereas failure on the Babcock sentence in a patient above the defective level of intelligence is strongly suggestive of memory impairment, adequate performance does not necessarily mean that no impairment is present. A really satisfactory test would require a series of items suitably graded in length and difficulty.

Our third learning test is a performance test (Rey, 1934). This test consists of four six-inch square boards on each of which are three symmetrical rows of three pegs. Eight of the nine pegs on each board are removable; one is fixed. The fixed peg is in a different position on each board. The boards are presented in a constant succession and the patient required to discover the fixed peg by trial and error. The boards are then given again in the same order and the patient repeats the procedure. This is continued until the patient can demonstrate unhesitatingly the position of the fixed peg on all four boards on two consecutive trials. When learning is complete, the test may be prolonged according to Davis's method (Davis, personal communication) by rotating the four boards through 90, 180 and 270 degrees and testing the patient at each new orientation. If he fails at any point the learning procedure is resumed as before.

An organic retention defect has a twofold effect on the Rey-Davis performance test. In the first place, learning is apt to be slow. This is particularly marked if the defect is severe. In the second place, a number of qualitative deviations from normal performance may be observed. These include: (1) *Stereotyped error*: A pattern of response evolved on any one trial is repeated on several successive trials with the same board. (2) *Confusions of sequence*: The response appropriate to any one board is consistently elicited by one of the other three. (3) *Unstable learning*: Continued testing provokes breakdown on one or more boards after learning is apparently established. (4) *Forgetfulness*: Errors occur which are apparently due to transient absent-mindedness and are often self-corrected. (5) *Breakdown on rotation*: Rapid learning at the standard orientation of the boards is followed by breakdown and inadequate re-learning after one or more rotations. These five characteristics do not occur exclusively in organic cases and not every organic case can be relied upon to display them. Where some or all are observed, however, and in the absence of certain characteristics of performance discussed below, an organic impairment is indicated.

The Rey-Davis test is not reliable in patients of high intelligence. Such patients are appreciably helped by their high-grade immediate memory span and may also develop ingenious methods of overcoming disability. The use of mnemonic formulæ is one such method, though it is less common than might be supposed. The test must also be applied with due discretion in the case of emotionally labile patients or those especially prone to "catastrophic" breakdown.

The learning defect as displayed in these simple experimental settings appears sufficiently constant and uniform to justify further research and eventual standardization of appropriate tests. Results on learning tests correlate well with clinical estimates of retention defect. Special care should however be exercised in cases of high intelligence and in those with residual dysphasic signs. The latter often show a selective impairment of verbal learning and their performance on the first two tests is no indication of learning capacity in non-verbal fields. Great care is also necessary in assessing cases of post-traumatic syndrome with clinical indications of mild retention defect. In these cases the defect is typically expressed in an exaggerated forgetfulness and proneness to absence of mind. Many such cases give an essentially normal performance on learning tests. It appears rather unlikely that valid tests for these mild and fluctuating amnesic conditions can be developed. The defect is so commonly displayed in situations affording greater distraction and competition of motive than it is possible to duplicate in an experimental setting.

There are some characteristics of neurotic behaviour which we have observed on tests of memory. Our material is rather limited in view of the fact that an organic component cannot be completely excluded in many of the cases of post-traumatic neurosis referred to us for assessment. But we have some evidence that patients with anxiety states or hysterical reactions give characteristic reactions on the tests. In the first place, neurotic performance is apt to be highly variable and inconsistent. On the digit test, for example, the patient may fail to repeat a set of 4 digits but manage one of 7 without apparent difficulty. A similar inconsistency is often found with the digit and sentence learning tests. Thus correct repetitions may alternate with gross failures; complaints of forgetting and the like are very common. In the second place, functional cases may give anomalous results on tests of reproducing short stories. In organic cases, complete failure to reproduce the gist of a short story is to be expected only in cases with very gross involvement of memory or language. Some neurotic patients, however, consistently fail to reproduce short stories under test conditions. Others manage to recall a



sequence of 7 digits correctly after eleven consecutive attempts. A second case, of high general intelligence, was able to repeat 8 digits on the first trial but required no fewer than nine consecutive trials to learn a sequence of 9 digits. A third case, tested first while still somewhat confused, had a basal span of 6 digits but was entirely unable to learn a sequence of 7 digits. After recovery of normal consciousness this patient could learn 7 digits in four trials but required eight trials to learn a set of 8 digits. These results are representative of a large group of cases with moderate post-traumatic memory impairment.

A shortcoming of the digit test is the artificial nature of the material and the relatively uninteresting task. Our second test approximates more closely to normal conditions of rote learning. The sentence we use is adapted from Babcock's Sentence Repetition test (Babcock, 1930). It reads: "One thing a nation must have to become rich and great is a large secure supply of wood." The sentence is repeated alternately by the examiner and the patient until the latter gives two consecutive word-perfect versions. It is necessary to emphasize that the rate of learning this sentence depends to a considerable extent on the immediate verbal memory span. In patients of superior intelligence the latter is usually high. Highly intelligent patients may repeat the sentence correctly after one or two trials despite an outspoken retention defect. In such cases it is necessary to use a longer paragraph for testing rote learning. But in a majority of cases the Babcock sentence suffices for routine purposes.

We hope in due course to standardize the sentence learning test with normal subjects at different age and intelligence levels. Provisionally, we assume that if more than eight consecutive repetitions are needed for correct recitation in the case of a non-psychotic patient above the defective level of intelligence some retention defect is indicated. Defective learning, moreover, is shown not only by retardation but also by striking qualitative features. It is common, for example, to find an inaccurate version persisting in whole or in part throughout the series of reproductions. The slightly unusual content and syntax of the sentence give exceptional difficulty to many patients. These features are well brought out in the following examples. The first is a case of moderately severe post-traumatic intellectual impairment. There was no dysphasia and intelligence tests were performed very adequately (Score 53 on Raven's Matrices). There were some clinical indications of memory defect. Twelve attempts to repeat the Babcock sentence were made without complete success on any trial. A few of these may be quoted:

*Repetition 1*: "One thing a nation must have to secure . . ."

*Repetition 3*: "One thing a nation must have to become secure and great."

*Repetition 6*: "One thing a nation must have to become rich and great is to have a large proportion of wood."

*Repetition 9*: "One thing a nation must have to become rich and great is to have a large supply and proportion of wood."

The version given in *Repetition 9* was repeated unchanged on three further trials after which the test was given up. One may note that this patient was on no occasion able to reproduce the word "secure" in its proper place and was unable to eliminate the word "proportion" which he himself introduced on the 6th trial.

A second example is given by a case of frontal lobe tumour tested post-operatively. This patient showed little, if any, intellectual impairment on ordinary mental tests. His learning, on the other hand, was definitely unsatisfactory. Two attempts on the Babcock sentence may be quoted:

*Repetition 1*: "One thing a nation must require is a lot of wood."

*Repetition 6*: "One thing a nation must have to become rich and great is a large supply of wood."

The version given in *Repetition 6* was repeated unaltered on four further trials after which the test was abandoned. One may note that the word "secure" was never introduced into a reproduction despite its repetition ten times by the examiner in the sentence.

These examples show both the stereotyping effect with repeated reproduction and the difficulty in learning unusual features of content or syntax. A special study of these characteristics would probably throw light on the psychology of the organic retention defect itself.

It has been mentioned that the Babcock sentence is unsuitable in cases of high general intelligence. One such case, with a pronounced amnesic syndrome, was able to repeat the Babcock sentence without error after three repetitions. But he was unable to learn an 80 word paragraph by heart even when it was divided into shorter parts and the learning distributed over several sessions. This patient attempted in all eighty

repetitions of the passage without success. It follows that whereas failure on the Babcock sentence in a patient above the defective level of intelligence is strongly suggestive of memory impairment, adequate performance does not necessarily mean that no impairment is present. A really satisfactory test would require a series of items suitably graded in length and difficulty.

Our third learning test is a performance test (Rey, 1934). This test consists of four six-inch square boards on each of which are three symmetrical rows of three pegs. Eight of the nine pegs on each board are removable; one is fixed. The fixed peg is in a different position on each board. The boards are presented in a constant succession and the patient required to discover the fixed peg by trial and error. The boards are then given again in the same order and the patient repeats the procedure. This is continued until the patient can demonstrate unhesitatingly the position of the fixed peg on all four boards on two consecutive trials. When learning is complete, the test may be prolonged according to Davis's method (Davis, personal communication) by rotating the four boards through 90, 180 and 270 degrees and testing the patient at each new orientation. If he fails at any point the learning procedure is resumed as before.

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part of the story (often the beginning) but allege that the rest has been forgotten. In general, inability to recall the gist of a short story in the case of a patient lacking the signs of gross intellectual impairment suggests a functional condition.

The Rey-Davis test can also be helpful in assessing functional memory impairment. The test behaviour of a neurotic subject, it is true, often resembles an organic case. Learning is not infrequently slow and stereotyped patterns of error may be recorded. But the performance as a whole gives a very different impression to the experienced tester. Peculiarities of tempo and procedure, rare in uncomplicated organic cases, are very common. Thus undue hesitation in choosing a peg when confronted with a given board may be followed by an over-rapid movement of selection ("hover and pounce" reaction). Alternatively, the patient may examine the pegs with an almost feverish rapidity and in many cases re-examine pegs which he has found to be movable a few seconds earlier. Overt expressions of anxiety (e.g. sweating) are not uncommon and relatively easy to distinguish from the sudden "catastrophic" reaction of the organic case in the face of excessive difficulty. These features are hard to record quantitatively but easy to recognize in practice.

The appearance of "neurotic behaviour" does not necessarily exclude concomitant organic impairment. We have had occasion to test a few cases of post-traumatic neurosis in which there was good ground for anticipating more basic intellectual impairment on an organic basis. These cases have uniformly exhibited neurotic patterns of reaction on the tests. The dominant emotional reactions effectively masked any organic retention defect that might have been also present.

The use of simple learning tests appears to define two varieties of impairment: (1) Commonly called the organic reaction type; and (2) what might be called the neurotic pattern. It is suggested that the fundamental characteristic of the organic type is an *impairment of learning*. In severe cases, learning the test material is slow and incomplete and is often associated with perseveration and inability to correct error with practice. In less severe cases, learning may be somewhat retarded and unfamiliar features of the material present exceptional difficulty. The basic feature of the neurotic pattern appears to be *exaggerated variability* of response with a notable tendency to fail on easy tasks. This appears to reflect an emotional disorder which may or may not be restricted to memory. But it is important to recognize that a neurotic pattern of test behaviour may effectively mask concomitant impairment of the organic variety.

The differential criteria of memory defect cannot yet be defined sharply on the basis of mental tests alone. In the organic reaction types, however, the learning defect is almost certainly a primary (or "negative") symptom relatively constant in character. Simple rote learning tests suffice to detect it in a majority of cases. In assessing the mildest grades of organic impairment, however, and in differential diagnosis generally, the psychologist must be content to subordinate his findings to the wider framework of psychiatric experience.

I wish to thank Mr. Norman Dott and Dr. Andrew Paterson for their encouragement and valuable help in this work.

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## Section for the Study of Disease in Children

President—DONALD PATERSON, M.D.

[May 29, 1943]

MEETING AT BASE HOSPITAL, HEMEL HEMPSTEAD

**Diabetes Insipidus, its Clinical Features and Treatment.**—W. G. WYLLIE, M.D.

[Dr. Wyllie referred to five cases of diabetes insipidus recently seen in children of which two were demonstrated. These two were put forward as examples of idiopathic diabetes insipidus. The other three were "symptomatic", two being caused by cerebral neoplasms and one following a fracture through the base of the skull. All were in males.]

*The symptomatic group* can arise from many causes and at any age. Some of the causes are cerebral neoplasms in the region of the floor of the third ventricle, the effects of an encephalitis and of syphilitic meningo-encephalitis in the same area, also fracture through the base of the skull. The condition is also a component of the syndrome called Schüller-Christian lipoidosis, in which multiple defects in the membrane bones of the skull, exophthalmos and diabetes insipidus commonly occur. A normal standard of urinary output depends upon integrity both of the pars posterior of the pituitary and of centres in the floor of the third ventricle.

A. Of the two *neoplastic cases* one was in a boy of 8 years with eight months' history of excessive thirst and micturition with bed-wetting at night. The greatest recorded daily intake was 16 pints of fluid, output 14 pints. He showed precocious genital hypertrophy, hirsuties absent, an adult formation of musculature (fig. 1), had a deep gruff voice, and complained of itching of the skin of the head and back. The urine was pale, of low specific gravity, sugar absent; W.R. negative; X-ray of skull, no widening of the sutures; optic fundi and fields normal.

At the end of eight months evidence of intracranial hypertension supervened, headache localized to the root of the nose, occasional vomiting, drowsiness, early swelling of both optic discs. The visual fields were normal. Ventriculography by Mr. W. McKissock, at the Atkinson Morley Hospital, showed the cortex under tension, both lateral ventricles and the *anterior* two-thirds of the third dilated, with downward displacement of the aqueduct of Sylvius. The appearances suggested a globular tumour in the region of the pineal. At operation 8.4.43 Mr. McKissock found a reddish vascular tumour which proved to be a glioma of benign type (fig. 2). The child did well for several days, but died 16.4.43.

B. The other *neoplastic case* was in a boy of 8 years, of average weight (about 52 lb.), and of rather stunted appearance, who in June 1941 developed polydipsia, 13 to 14 pints daily, polyuria about 12 pints, commencing a few weeks after an ordinary attack of measles. When first seen at seven years his head looked large but measured 21 in., X-ray showed no widening of the sutures. The central nervous system, fundi, visual

fields, &c., were normal except for inequality of the pupils, the R. being smaller than the L., both reacting briskly to light. W.R. negative in blood and cerebrospinal fluid. Urine: Low specific gravity, no sugar. Frequent bed-wetting. Blood-pressure 110/86.

Twelve months from onset of symptoms the circumference of the head measured 22 in.; R. pupil still being smaller than the L. X-ray of skull showed no opening of the sutures. Eighteen months from onset headache, vomiting, drowsiness and mental alteration were noticed, and later dimness of vision was complained of, while the thirst and urinary output diminished to nearly normal quantities without any change in the pitressin therapy. The visual fields appeared full; fundi showed early blurring of the nasal edges. Genital hypertrophy was absent.

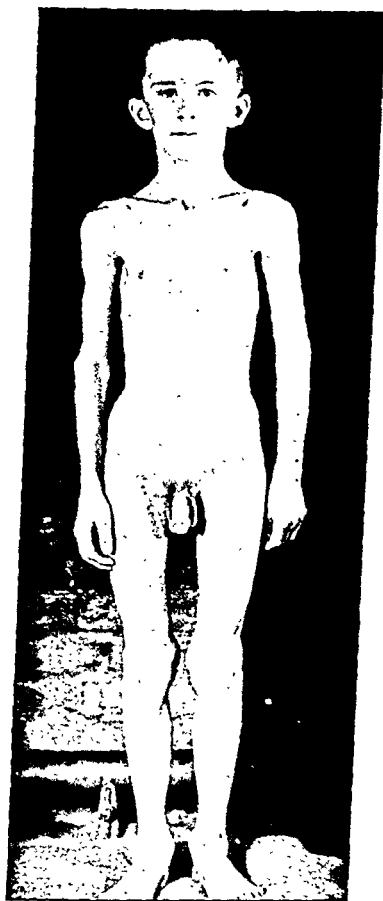


FIG. 1.—Case A.—Scarcity of fat, adult configuration, precocious puberty.

On ventriculography (Mr. McKissock) the cortex was seen to bulge, and there was symmetrical dilatation of both lateral ventricles but no air entered the *anterior* third of the third ventricle. The appearances suggested a large tumour filling the *anterior* third of the third ventricle and extending upwards and backwards into the posterior part. The child's condition and the position of the tumour contra-indicated surgical approach. The child died 8.4.43, and autopsy was not permitted.

C. The third symptomatic case was in a boy of 7 years who in a road accident sustained a fracture of the skull involving the base. About three months after the injury

diabetes insipidus commenced. He remained in good health otherwise up to 12 years of age when he was lost sight of.

Notes on the pitressin treatment of these three cases are given later.

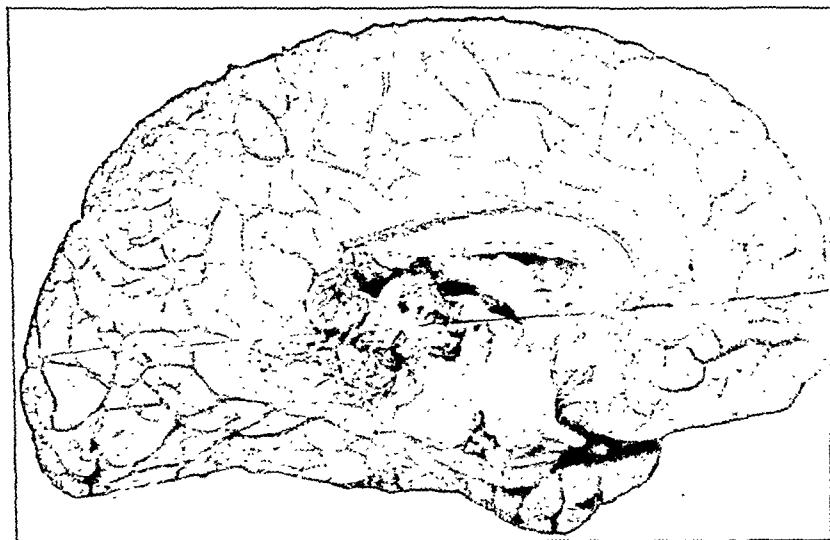


FIG. 2.—Case A.—Tumour, in the region of the pineal gland, proved to be a benign glioma.

#### IDIOPATHIC CASES

D. Boy of 6 years who for two months without apparent cause suffered from excessive thirst accompanied by anorexia, polyuria, enuresis. Urine: Specific gravity 1005-1012; Mantoux negative; W.R. negative; X-ray of skull normal; central nervous system normal.

		Intake	Output
Untreated	...	daily 4—11½ pints	4—9½ pints
Pitressin sol. miv	intramuscularly daily	3½—11 "	4½—6½ "
" mvi	"	5—9 "	4—5½ "
" tannate in oil miv	intramuscularly daily	2½—7 "	2—7 "
" "	" mvi (alternate days)	2½—10 "	2½—9½ "

On the ordinary pitressin solution daily doses of 4 to 6 minims caused unpleasant reactions of pallor, colic, even bowel action ten minutes after the injection.

E. Boy of 13 years, who, following pertussis at 6 years, developed polydipsia, 7 to 19½ pints daily, polyuria 6½ to 18 pints, and frequent enuresis. Urine: Specific gravity 1,000, no sugar; W.R. negative; Mantoux negative; X-ray of skull normal.

	Intake	Output
Pitressin sol. mvii intramuscularly daily	No effect	—
Pitressin sol. mxv intramuscularly daily (reaction, abdominal pain, pallor)	3½—13½ pints	2½—11½ pints
Pitressin tannate in oil, miv intramuscularly daily	6½—10½ "	5½—12½ "

In four of these cases in which the sodium chloride concentration test was used, giving 10 gm. salt at 9 a.m., the abnormally low hourly percentages of NaCl suggested or was confirmatory of a diagnosis of diabetes insipidus.

*Pitressin therapy.*—The results of pitressin therapy in the above five cases of diabetes insipidus in children were extremely erratic. In one, the case of fractured skull, ½ c.c. of ordinary solution of pitressin (20 international units per c.c.) intramuscularly daily, acted dramatically, keeping the intake and output almost in natural limits and without undesirable side-effects such as colic. The same solution in the other four cases was ineffective except in doses which produced unpleasant reactions.

Attempts have been made to produce a delayed action pitressin compound. One, an emulsion in woolfat, beeswax and olive oil, solid at room temperature, gave promising results but was abandoned because of the formation of paraffinomas at the sites of injection. The most promising preparation so far is that devised by Court and Taylor of pitressin tannate in oil. This contains only 5 international units per c.c. and may become more effective in the future if a more concentrated preparation is prepared. Experience with this preparation in four of the above cases showed that a small daily intramuscular injection of 4 minims was more effective than larger doses on alternate days, which also are apt to produce unpleasant reactions. The small daily dose was more likely to keep intake and output between 7 and 12 pints, at which level enuresis usually ceased and social life at home and at school was happier and nearer normal. These children if uncontrolled are water-addicts, stealthily drinking the contents of flower vases and even of hot-water bottles if access to the water-tap is made difficult.

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### Cystic Conditions in the Lung.—C. ELAINE FIELD, M.D.

Intrapulmonary cystic conditions of the lung may be differentiated into those usually considered congenital in origin and those developing after birth.

**Congenital.**—Undoubtedly some cystic conditions of the lung are developmental in origin. It is not surprising that the complex system of branching sometimes falls short of perfection. The cysts in the foetus are single or multiple, containing mucoid, colloidal, or a watery fluid, and although they do not communicate with the bronchial tree probably originate from it embryologically (Klebs, 1889; Smith, 1925; Wolman, 1930). Shortly after birth these cysts usually rupture into a bronchus and become air-containing (King and Harris, 1937). If the opening is of the ball-valve type a tension cyst will be produced.

**CASE I** (Previously reported by Illingworth, 1939).—A girl, aged 6 2/12 years, first attended hospital at the age of 1 year for cough and restlessness. On routine examination and X-ray a large multilocular tension cyst was discovered in the right chest. Lipiodol failed to enter the cyst although the compressed right lower lobe was filled. She also suffers from recurrent pyelitis, an intravenous pyelogram showing bilateral double renal pelvis and ureter.

The frequency of other congenital anomalies in association with cystic lungs supports the congenital theory of origin. Case I has bilateral double renal pelvis and ureter and Case II has associated diabetes mellitus and possible cystic pancreas.

**CASE II.**—A boy, aged 6 1/2 years, first seen at 2 1/2 years suffering from cough and enteritis. There was no history of a previous illness. It was then discovered by X-ray that he had multiple cysts at the base of both lungs as well as diabetes mellitus. The cysts were infected. His abdomen was always large but is slowly increasing in size; palpation reveals no definable mass or detectable fluid and the possibility of a pancreatic cyst has been considered. The family history is interesting. Mother and father have normal chest X-rays, but a younger sister who died when a year old from pneumonia and whooping-cough was found, at autopsy, to have bilateral cystic lungs. Two older children are healthy.

Once the cysts have become infected it is difficult to differentiate clinically between the congenital and acquired condition unless the onset of infection is dramatic as in Case III. However, the absence of any illness likely to produce lung damage is strongly suggestive of a congenital origin.

**CASE III.**—A girl, aged 3 3/12 years, was quite well until four months before admission when she contracted whooping-cough. Six weeks later she started coughing up copious quantities of foul-smelling sputum and X-ray (fig. 1) revealed multiple cystic areas, about the size of grapes, in the mid and lower zones of both lungs. The onset of infection in this case almost certainly occurred shortly after contracting whooping-cough, and as six weeks seems too short a period to produce cystic bronchiectasis of such severity, it is presumed that the condition is congenital in origin.



FIG. 1.—Case III.—Right lateral X-ray showing multiple cystic areas with fluid levels in the lower and middle lobes. Infected congenital cysts.



FIG. 2.—Case IV.—Right lateral X-ray showing several large cystic spaces in the middle lobe. Probably emphysematous bullae.



*Acquired.*—Chronic lung infection resulting in dilatation of the bronchioles in a young infant will soon produce a cystic condition clinically indistinguishable from infected congenital cystic lungs of the small variety. However, there is also a condition following pneumonic consolidation in which one or several cystic spaces appear and enlarge, sometimes to an alarming size, then retrogress and completely disappear (Barclay, 1943). The most satisfactory explanation so far for this phenomenon is that a ball-valve mucous plug lodges in the bronchiole and distends the alveoli. Case IV probably falls into this category.

CASE IV.—A girl, aged 11 5/12 years, suffering from Banti's disease complicated by a chronic bacteraemia, developed in the course of the disease a cough with sputum and a raised temperature. X-ray of the chest revealed an opacity in the right mid-zone which slowly cleared over a period of three months into multiple cystic spaces in the right middle lobe area (fig. 2). These cysts remained unchanged for two months and then disappeared.

*Treatment.*—Removal of the diseased part, if within surgical possibilities, is the ideal in all infected cases whether congenital or acquired. It would also appear to be the ideal treatment in non-infected cysts where there exists a continual danger of infection. However, until lobectomy and pulmonectomy carry with them a negligible mortality, I think it advisable only to recommend the operation in those cases where the cysts are producing symptoms or are already in free communication with a bronchus, that is when they easily fill with lipiodol. These latter type are more liable to infection.

The acquired cystic emphysematous bullæ are best left alone as they usually subside spontaneously.

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#### Hirschsprung's Disease.—MARGARET HAWKSLEY, M.B.

Five cases of megacolon were shown. They were selected from a series of fourteen cases to demonstrate certain points in the differential diagnosis of Hirschsprung's disease, and its treatment by spinal anaesthesia.

The first two cases illustrate not only the importance of a complete examination, but they also show the absence of two distinctive features always present in a case of Hirschsprung's disease, namely, visible peristalsis, and retention of barium enema for twenty-four hours. In twelve cases of the disease (not yet published) these features were never absent.

C. S., female aged 2½ years. Dribbling incontinence of faeces since 5 weeks old with abdominal distension. She is an undersized child with large abdomen and visible peristalsis. X-ray of a barium enema shows a large sac-like colon, no evacuation after twenty-four hours. Rectal examination under spinal anaesthesia reveals a tight fibrous stricture in calibre about the size of a pencil; obviously the cause of her megacolon. Dilatation under anaesthesia is improving the condition.

D. H., male aged 5 years. Attacks of constipation for two years, abdominal distension with pain and bowels not open for nine to ten days. Incontinence of faeces at other times. Examination reveals a child of subnormal intelligence, no abdominal distension, no visible peristalsis. Rectal examination normal. Barium enema shows distended colon when filled but perfect evacuation in twenty-four hours with normal calibre and haustration. He is a behaviour problem and will undergo psychotherapy.

If, in this case, only the immediate picture had been seen, Hirschsprung's disease might have been diagnosed but the twenty-four hour picture with perfect haustration and evacuation rules the diagnosis out.

Of the three true cases shown, two are cured and one, a severe case, is improving.

N. H., male aged  $8\frac{1}{2}$  years. Constipation five to seven days since he was 2 years old. Abdominal distension and large stools. X-ray January 1940 showed colossal colon. February 1940: High spinal anaesthetic; a motion was passed on the table. About four weeks later he was passing normal daily motions and has done so ever since. Now, over three years later, he has no distension, and has a daily bowel action. X-ray November 1942 shows no change whatever in the size of the colon (figs. 1 and 2).



FIG. 1.—N. H., January 1940.



FIG. 2.—N. H., November 1942. Functional cure. Anatomically no change.

D. W., male aged  $6\frac{1}{2}$  years. Constipation since birth, abdominal enlargement, large motions. X-ray showed megacolon. March 1940: Spinal anaesthetic, repeated after three weeks. No improvement ensued and he was discharged to have a monthly evacuation under anaesthetic, but this proved unnecessary. In December 1940 bowels were open daily and this has continued ever since. Present X-ray shows gut of nearly normal size but no haustration, good evacuation in twenty-four hours.

A. S., male  $11\frac{1}{2}$  years. A severe case with typical history. February 1942: He was a thin pale miserable child with enormous abdomen, girth  $32\frac{1}{2}$  in. April 1942: High spinal anaesthetic given; no immediate improvement but in June 1942 he was having spontaneous bowel actions and his abdomen was less distended. July 1942: High spinal anaesthetic repeated. January 1943: Daily bowel actions, general health and energy much improved. June 1943: Some return of symptoms though otherwise very well. Spinal anaesthetic repeated. X-ray shows enormous colon.

These three cases are selected from a series of 12, 6 of which are cured functionally, ranging from three to one years since treatment, 5 are improving but only twelve to six months have elapsed since treatment, and 1 is no better but he is a severe case and complicated by sympathectomy.

The salient points emerging from a study of these cases are: (1) No immediate action on the table should be expected, it may or may not occur but is irrelevant to the subsequent progress of the case. (2) An immediate alteration in bowel habits need not occur either; all except one case did not improve till about four weeks later. (3) More than one spinal anaesthetic may be required. (4) A barium enema can mislead the physician in diagnosis unless a twenty-four-hour evacuation picture is taken.

I think that a hopeful view may be taken of the effect of spinal anaesthesia on Hirschsprung's disease, but time—say at least a year—and repeated anaesthetics should be given before a case should be judged *unsuccessful*. Comparatively, spinal anaesthesia gives as

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## Section of the History of Medicine

President—Sir WALTER LANGDON-BROWN, M.D.

[May 5, 1943]

### John Bulwer (fl. 1654) The "Chirosopher"

Pioneer in the Treatment of the Deaf and Dumb and in Psychology

By H. J. NORMAN, M.B.

THE name of John Bulwer is little known these days; his few books are scarce and some of them even rare and difficult to find—yet no one has so far reprinted any of them though they do seem to merit such reviviscence; and, though he must have been quite a considerable figure in his day, there is no record where or when he was born nor where or when he died. The Dictionary of National Biography states merely that he flourished in 1654—actually if one may judge from the dates of publication of his books he showed considerable vitality during the preceding ten years. In 1644 was published his *Chirologia, or the Naturall Language of the Hand: whereunto is added Chironomia*; and in 1654 appeared the second, quarto edition of his best known work, *Anthropometamorphosis: Man Transform'd, or the Artificial Changeling*. Prefixed to the quarto edition there is a fine portrait by Faithorne and this also would seem to indicate that Bulwer was a person of some importance. (It was done probably between 1650-53, as Faithorne, the elder, who had been banished during the Protectorate was allowed to return to England in 1650.)

Bulwer lived in an age when men's minds were reaching out in all directions; and of all of these speculators the most powerful was Francis Bacon, the repercussions of whose mighty intellect are endless. "And to say truth", says his biographer, Mallet, writing some hundred years later, "some of the most valuable improvements since made have grown out of the hints and notices scattered thro this work (*De Augmentis*); from which the moderns have selected, each according to his fancy, one or more plants to cultivate and bring to perfection."<sup>1</sup> Explicitly Bulwer was influenced by Bacon. In the Epistle Dedicatory to his *Pathomyotomia* he speaks of his correspondence with Dr. Wright Junior,<sup>2</sup> "with whom having interchangeably communicated on Intellectual Affairs, he shewing me the hint of his grand undertaking, which was *Anatomia Comparata*, that great defect in Anatomy noted by my Lord Bacon in his book *De Augmentis Scientiarum*". Other references which he makes to Bacon show clearly the opinion which he held of him; for example, in *Philocophus* he describes him as the "Verulamian Oracle" (p. 16), the "Great Advancer of Learning" (p. 31), the "Great Augmentor of Sciences" (p. 46) and as that "Hero of Learning" (p. 69).

There was the same excursive spirit about Bulwer that characterized so many of his contemporaries and immediate predecessors; and, though he was not free from the discursiveness and euphuism which were also characteristics of the time, he was able to turn his energies into practical and useful channels. "It has ever been the humour of my Genius to put me upon untrodden Pathes", he says in the dedication to *Anthropometamorphosis*. One result of this is that his name, though little known, is remembered as the pioneer in this country in the treatment of deaf-mutes.<sup>3</sup>

He describes himself as M.D. but it is not known where he studied or where he obtained his qualification. He was the son of a doctor, Thomas Bulwer, to whom he dedicated his *Pathomyotomia* in 1649, and of whom even less is known. In the Epistle Dedicatory he says, "It hath been a laudable Custome with Persons of eminent degree

<sup>1</sup> *Life of Francis Bacon*, by D. Mallet (Lond. 1740, p. 156). "English writers of the later 17th century concur in ascribing to the impetus of Bacon's writings the foundation of the Royal Society" . . . It is perhaps in the department of psychological speculation that the influence of Bacon has been most marked. . . . Whatever his positive achievements may have been, we may thus accord to him his own claim that he "rang the bell which called the wits together."—Dr. Charles Singer—article "Francis Bacon", *Encyc. Brit.*, 14th Ed., 1923.

<sup>2</sup> Dr. Robert Wright, at one time in the service of Dr. Fludd and who apparently died prematurely after showing much promise. He was named Gultonian lecturer for 1647 but died in 1646. Munk's Roll of the R.C.P.: I, 235.

<sup>3</sup> See, for example, *Encyc. Brit.* (14th edn.): article, "Education and Welfare of the Deaf and Dumb."

good, and probably better, results than sympathectomy which is often disappointing in so far as the immediate improvement is not maintained. Furthermore there is no operative risk.

Briefly the technique employed is as follows: Light percaine 1/1,500 [Sp. gr. 1.0038, therefore lighter than C.S.F.] *either* 1 c.c. per year age of child, *or* following the Howard Jones formula  $P=D-6$ .  $P$ =percaine in c.c.,  $D$ =distance in inches from seventh cervical spine to the intercostal line with the back flexed, whichever gives the *smaller* dosage. Injection into the second to third lumbar space with the child sitting up. He remains sitting for twenty seconds, then lies on his back with shoulders raised for about five minutes, the height of anæsthesia being tested at intervals. After five minutes the table is tilted head downwards so that the percaine will not continue to ascend towards dangerous levels. The full result is not apparent till fifteen to twenty minutes and anæsthesia is then usually up to the nipple line (T4) or higher. A rectal examination is done and fæces removed, and an attempt made to feel the pelvirectal junction and assess its degree of spasm, if any. Achalasia is more often there than at the anus. If spasm is present the sphincter should be dilated so that the peristalsis which occurs may be effective. Ephedrine gr.  $\frac{1}{4}$  intramuscularly is given before the spinal to counteract the fall in blood-pressure which would otherwise occur.

With regard to the theory behind these results there is no better suggestion than that made by Professor Telford in 1939, namely that the condition is due to overaction of the sympathetic, and that the imbalance of the autonomic nervous system is corrected by temporary paralysis of the sympathetic under spinal anæsthesia; but this leaves many questions unanswered. Why should paralysis of overacting fibres lead to their subsequent return to normal function? Why should some cases react in a short time and others require longer, and more than one spinal anæsthetic? And how do some cases function normally in the face of X-ray evidence of colons anatomically as large as they were at the first examination (Case N. H.)? One can only place the results on record with a plea for more persistent trial of spinal anæsthesia before proceeding to operation.

Sir Kenelm Digby's books, Bulwer's *Artificial Changeling*, Sir Thomas Browne's *Vulgar Errors* . . . These books were much read and admired in our author's days". Butler was a contemporary—he was about 38 when the *Anthropometamorphosis* was published and it is possible that he knew Bulwer.

One would like to know if he had any personal contacts with the learned men of his age, a number of whom he mentions, but no record of this appears to exist. He wrote during the later years of the reign of Charles I, and then during the Commonwealth but there is nothing very specially to indicate that these events had any particular influence on his career. It is but seldom that he makes any reference to them; though as one of the examples in *Chirologia*, when describing the movement of extending and raising up "both the Hands to Heaven" he says: "Such an asseveration of gesture I lately observed in some at the publique taking of the last National Covenant" (this was in 1638). Again when describing the "Imposition of the Hand" he instances the royal touching for scrofula or struma which "from the constant effect of that Sovereigne Salve is called the King's Evil. His sacred Majesty that now is hath practised with as good successe as any of His Royall Progenitours" (*Chirologia*, p. 149). It would appear that he was one of those of whom Macaulay<sup>5</sup> said: "While factions were struggling for dominion over each other, a small body of sages had turned away with benevolent disdain from the conflict, and had devoted themselves to the nobler work of extending the dominion of man over matter."

Among those to whom he refers are Sir Kenelm Digby whose *Treatise of Bodies and of Man's Soul* was published in the same year as *Chirologia* and *Chironomia*, 1644, as was also Donne's *Biathanatos*. In the previous year appeared *Religio Medici*; and in 1646 *Pseudodoxia Epidemica*. Harvey's *De Generatione Animalium* (1651) was published the year following the appearance of *Anthropometamorphosis*. Purchas, to whose travel-books he made frequent reference, had died some years previously in 1626. Captain John Smith (1579-1631) published his *General History of Virginia, &c.*, 1624, and *True Travels*, 1630. It may not be without interest to note certain other contemporaneous publications such as Hobbes' *Leviathan*, 1651; Walton's *Compleat Angler*, 1653; Urquhart's translation of Rabelais, 1653.

Of his great exemplar, Francis Bacon, he may have read some of the later works at the time of their publication; the *Novum Organum* was published in 1620, the *De Augmentis* in 1623, *Sylva Sylvarum* and *New Atlantis* in 1627.

### CHIROLOGIA and CHIRONOMIA

These two works, published in 1644, appeared under the same cover and with a common title-page—in most instances—though they were also apparently issued separately. Both of them, as their names imply, are concerned with the hand, not, however, in the manner of Sir Charles Bell whose *Bridgewater Treatise on The Hand* deals with the subject from the intrinsic point of view, while Bulwer's interest is in the extrinsic aspect, that of gesture.

*Chirologia* is, in his own words, the "Naturall Language of the Hand. Composed of the Speaking Motions, and Discoursing Gestures thereof". At this time he had not adopted the cognomen of the "Chirosopher", but describes himself on the title-page as "Philochirosophus". He acknowledges again his debt to Bacon "that great Light of Learning" who had noted that in the study of humanity there is a "maine deficiency, one Province not to have been visited, and that is Gesture". It seems as if he had already conceived the idea of his *Pathomyotomia*, for a little later he says: "I confesse some other of my digested thoughts strugled for precedencie, claiming by the analogie of Natures usuall course the Head would have had the privilege of primogeniture: But it fell out in the contention somewhat like as in the case of Tamar's twins, where Sarah put forth his Hand, and the midwife said, *This is come out first.*" (Dedicatory Epistle).

In his introduction to *The Candid & Ingenious Reader* he gives a hint also of his *Philocophus* for he says: "As the Tongue speaketh to the Eare, so Gesture speaketh to the Eye." This is strengthened by some of the comments in the commendatory poems which precede the book. In one of these occur the lines—

"The Hand & Meaning ever are ally'de  
All that are deafe & dumbe may here recrute  
Their language. & then blesse thee for the Mute  
Enlargements of thy Alphabets."

<sup>5</sup> Macaulay—*Essays*—"Bacon."

to descend to honour their Sonnes with directing Books unto them; the reciprocation of which affectionate Complement is a duty well-becoming a son; moved (therefore) with a certain Filiall Decency I made choice to dedicate this Book unto you in regard the Argument of it is Provinciall to Physick, wherein your experience hath crowned your Profession, having ever been *Fortunatus in Praxi*". That would seem to be our sum total of knowledge regarding Dr. Thomas Bulwer. It may be inferred that he was an elderly man at this time as, if one may judge from the portrait, his son was then of middle age.



Engraved by T. Berry, From a Scarce Print by Faithorne.

Although there is so little record of him it seems as if he was quite well known in his day. For example, Samuel Butler, in his *Hudibras* which was a very popular book, has several references to him, as we shall see when we deal with the *Anthropometamorphosis*; and one editor of Butler says that<sup>1</sup> "he frequently alludes to Purchas's *Pilgrimes*,

<sup>1</sup> *Hudibras*, by Samuel Butler; edited by Henry G. Bohn (London: Geo. Bell & Sons, n.d., Vol. I, 21).

of these in the same way; and again has similar graphic representations of certain of the gestures. Of biting the finger or nails he says: "This gesture is also a wilde expression of fierce anger and cruell revenge . . . The Italians, a revengefull Nation, doe most usually declare by this gesture their greedy coveting to be at Hand with revenge" (p. 160). Of feeling with the tips of the fingers: "A gesture whereby we know the Hand to be the judge and discerner of the touch, for although this touching vertue or tactive quality be diffused through the whole body within and without, as being the foundation of the animal being, which may be called *Animalitas* . . . we doe more curiously and exquisitely feele in the Hand, than in the other parts, and more exactly where the Epidermis or immediate organ of the outer touch is thinnest" (p. 171). In other words—*tactus eruditus*?

In passing he gives an answer to a present-day query, namely, how did we arrive at our method of computing numbers? "To begin with the first finger of the left hand, and to tell on to the last finger of the Right, is the naturall and simple way of numbering and computation: for all men use to count forwards till they come to that number of their fingers, and being come to that number, prompted as it were by nature to returne at this bound or But of numerically immensity . . . they repeat againe the same number returning unto unity from whence their account began" (p. 184).

Even at this early date he noted the facility which some of the deaf and dumb have of expressing themselves by signs. "A notable argument we have of this discoursing facultie of the Hand in our common jesters, who without their voice, speaking only by gestures, can counterfeit the manners, fashions and significant actions of men.<sup>7</sup> Which may be more confirmed by that wonder of necessity which Nature worketh in men that are borne deafe and dumbe; who can argue and dispute rhetorically by signes, and with a kinde of mute and logistique eloquence overcome their amazed opponents; wherein some are so ready and excellent, they seeme to want nothing to have their meanings perfectly understood" (p. 5); and again when dealing with the gesture "to lead one by the hand", he says: "For the hand as it speaks by signs unto the dumb, so in a more necessary garbe of speech it officiates in place of an eye, and speaking in the conducting dialect of a friendly assistance, supplies the defect of an ocular direction" (p. 84).

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Once again he searches "not only prophane, but sacred Authors" for exemplification that they have "taken notice of this solemne bond and Rhetoricall obligation between the Hand and the mouth, and have not only allowed the language of the fingers by which the ancients were wont to speake, but have likewise punctually set downe the office of these sidesmen the Hands and have gravely noted their necessary employment and concurrence to the more advantageous setting out of speech" (p. 7).

He gives us another glimpse of contemporary events. "That Virgin Monarch, Queene Elizabeth of famous memory. whose Apothegmes may passe among the Oracles of Rovall Reason. and Civill Prudence, having heard, or rather scene a Sermon that was preached

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and in another—

"And Natures silent motions shall advance  
Above the Vocall key of Utterance:  
Where every *Digit* dictates, & doth reach  
Unto our sense a mouth—excelling Speech."

Of the plan of the work Bulwer says: "I shall attempt to advance in the scrutiny and search after the scattered glances & touches of Antiquity, tracing them through most classicall Authors, with intent to reduce them into one continued & intire History, propounding this form to myself, to handle Gesture, as the only speech and generall language of Human Nature." So he proceeds to gather his examples from a variety of sources not only ancient but also modern; many are from the Scriptures and from the Patristic writings; he lays the Greek and Latin authors under contribution; and he quotes also from contemporary writers—Bacon, Burton, Donne, Camden, Barclay and others.

He deals with each of the various gestures under a separate heading, and many of them are made more clearly intelligible by the excellent pictorial representations of them in the plates which form part of the book and which are probably the work of William Marshall who was responsible for the fine title-pages of this book, of *Chironomia*, and of *Philosophus*. These compare very favourably with the crude workmanship of the illustrations of *Anthropometamorphosis*.

He describes the hand as "being the onely speech that is naturall to Man" and says that it "may well be called the *Tongue & generall language of Humane Nature*, which, without teaching, men in all regions of the habitable world doe at the first sight most easily understand". He points out how useful this proved to those doughty voyagers who had but recently begun to travel to the West Indies: "This is evident", he says, "by that trade & commerce with those salvage Nations. . . of the late discovered principalities of the West, with whom (although their Language be strange & unknowne) our Merchants barter & exchange their Wares."

One of his descriptions reminds me (I regret to say) of those individuals known on racecourses as "tick-tack" men, who so cleverly manage to transmit information long distances by movements of the hands and arms. "When we are beyond the vocall lines of communication with men, and that distance of place hath made the highest tone of our Tongue too low to reach the auditory nerve of one that is remote: or when the eare-deafing crowd hath rendered our Tongue unserviceable to declare our minde: we use the visible expressions of our Hand. . . which are as farre off perceived and understood by those who were uncapable of an auricular intimation." In other words Derby Day in normal times. And what a picture it calls up of the "eare-deafing crowd"! His comments on the gesture of "striking anothers Palm" which is, he says, "the habit and expression of those who plight their troth, give a pledge of faith & fidelity . . . buy, sell . . . etc." are in his best vein. To quote only a few: "The wilde Irish doe ordinarily use to swear by this seat of faith and minister of virtue, the Right Hand. who at every third word are wont to lash out an oath."

"But he that would see the vigour of this gesture in *puris naturalibus*, must repaire to the Horse Cirque, or Sheep Pens in Smithfield, where those crafty Olympique Merchants who need the Hand of no Broker to speed the course of their affaires, will take you for no chapman, unless you strike them good lucke, and smite them earnest in the palm. And I have sometimes in consort with my friend had good sport to let him observe the pure and naturall efforts of these men in the heat of their dealings, and have suffered my selfe to bee a little smitten with the Hand of deceit, to gaine the curiosity of an experiment, a kinde of solace, pleasing to Philosophicall complexions, and such who hunt after the subtleties of Nature: wherein though I cannot brag of my bargain, yet I can afford my Reader a good penniworth." (This, I venture to think, he has certainly done.) He continues: "Their cunning manning of the Hand in time and tone, I have sometimes call'd the Horse-Rhetorique of Smithfield, which by calculation I have found to differ from the Fish Dialect of Billingsgate, in the monochord of motion, and peaceableness of accent. And he that shall undertake to out-write Markham,<sup>6</sup> and like Hocus Pocus to discover the subtleties of his own profession, will not set forth the art of Hors-coursing well, if he omit the rule of buying and selling by this insurance and policy of the Hand" (p. 105).

He concludes *Chirologia* with a section which makes one wonder still more how it was that the finger-alphabet as we know it did not occur to him. It is entitled "Dactylosia or the Dialects of the fingers", and in it he deals with them as he has just done with the hand; but here "the articulated fingers supply the office of a voyce". He gives examples

<sup>6</sup> Gervase Markham (1568 ?-1637). *The Discourse of Horsemanshippe* (1593), etc.

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Whether Dr. Bulwer would have approved of the rest of the verse is another matter.

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In 1648 there appeared his *Philocophus; or the Deafe and Dumbe Man's Friend*. "Exhibiting the Philosophicall verity of that subtile Art, which may inable one with an Observant Eie to Heare what any man speaks by the moving of his lips. Upon the same Ground, with the advantage of an Historicall Exemplification, apparently proving, That a Man borne Deafe & Dumbe, may be taught to Heare the sound of words with his Eie, and thence learne to speake with his tongue."

In the course of a preliminary commendatory poem by his friend, Thomas Diconson, of the Middle Temple, there occur these lines which gives some indication of the scope of the little book. It is addressed to "His ingenious friend Philocophus on this Foundation of his intended Academie":—

"Rejoice you Deafe & Dumbe, your arms extend  
T'embrace th'inventive goodness of a Friend!  
Who heare intends, for your reliefe, to Found  
An Academie, on Nature's highest ground.

The Deafe & Dumbe get Hearing Eies which breake  
Their Barre of Silence, and thence learn to speake,  
Words may be seene or heard; W'are at our choyce  
For to give Eare, or Eie unto a Voyce."

It was dedicated to Sir Edward Gostwicke of Willington, Mr. William Gostwicke, his youngest brother, "and all other intelligent and ingenious gentlemen, who as yet can neither heare nor speake." Bulwer expresses his intention as follows: "What though you cannot expresse your mindes in those verball contrivances of man's invention; yet you want not *speech* who have your whole body for a Tongue, having a language more naturall

and significant, which is common to you with us, to wit gesture, the generall and universall language of Humane Nature, which when we would have our speech to have life and efficacy wee joyne in commission with our words, and when wee would speake with most state and gravity, we renounce wordes, and use Nods and other naturall signes alone."

He goes on to say that: "When coasting along the borders of *gesture*, and voluntary motion, I discovered a *community* among the Senses and that there was in the continent of *Humanity* a *Terra incognita* of *Ocular* audition . . . I found it to be one of the subtlest pieces of Recondite learning, and that it bordered upon other avenues unto the braine, as *Orall* and *Dentall* Audition, of which we have discovered sufficient ground to raise a new Art upon, directing how to convey intelligible and articulate sounds another way to the braine than by the eare or eye; showing that a man may heare as well as speake with his mouth. Upon which and other unlooked for discoveries, I began in idea, to conceive the modell of a *New Academie* which might be erected in favour of those who are in your condition, to wit, originally deafe and dumbe."

The greater part of the volume consists of a commentary upon the case of the "younger brother of the Constable of Castile who was born Deafe and consequently Dumbe" and of the admirable results achieved by treatment: "a notable instance of the industrious felicity of an observing wit in this kind." For the details of this he expresses himself as "extraordinarily beholding to that Gallant, and learned Knight, Sir Kenelm Digby" who had noted it during his stay in Spain, where he went in 1623 to join his uncle, Sir John Digby, Ambassador to the Court of Spain (p. 55).

The teacher to whom Bulwer refers, though he does not mention his name, was a Spanish monk, Juan Paulo Bonet, who taught the deaf to speak and who had published a book on the subject in 1620. Prior to this Pedro Ponce de Leon (b. 1520), a Spanish Benedictine monk, had practised the method suggested by Jerome Cardan (1501-1576) that the deaf could be instructed by writing and by signs. In the early ages the deaf were regarded as idiots and were killed out of hand. They had no place in the social order of things and were regarded as mere encumbrances. Later on, isolated instances are on record of the deaf being taught. The Venerable Bede (673-735) relates that in 700 St. John of Beverley taught a deaf-mute to speak.<sup>8</sup> Giovanni Bonifacio published his *Art of Signs* (*L'Arte de Cenni*) at Vicenza in 1616.

John Wallis (1616-1703), Savilian Professor of Mathematics at Oxford, published his *De Loquela* in 1652: and his "Letter to Robert Boyle, Esq., concerning the said Doctor's Essay of Teaching a person Dumb and Deaf to speak and to understand a Language" was published in the *Philosophical Transactions* (No. 61, p. 1087) in 1670. Wallis claimed that he was the originator of the teaching of the deaf and dumb; and he showed his first deaf pupil to the Royal Society in 1662, when it is stated "he hath been already with me somewhat more than two months." He was taken to Whitehall several times to demonstrate the results of teaching "in the presence of His Majesty, His Highness Prince Rupert, and divers others of the Nobility."<sup>9</sup> It is strange to note in the comment on his communication the writer says of his Treatise of Speech that is "the first book ever published in that kind"; for it was only those few years before that Bulwer had published his *Philosophus*. William Holder's *Elements of Speech* appeared in 1669; George Dalgarno, of Aberdeen, published his *Ars Signorum* in London in 1661, and his *Didascalaphus, or Deaf and Dumb Man's Tutor*, at Oxford in 1680;<sup>10</sup> and in 1692 Johann Conrad Amman produced his *Surdus Loquens*. It is evident, therefore, that interest in the subject had spread in this country, apparently as a result of what had been done abroad; but the fact remains that Bulwer was the actual pioneer, and this does not seem to be disputed, despite Dr. Wallis's claim. It was not, however, until 1760 that a school for the Deaf (Bulwer's "New Academy" at last!) was opened in Edinburgh by Thomas Braidwood; and at the same time one in Paris by the famous Abbé de l'Epée. In 1783 Braidwood moved to London and in 1792 the London Asylum for the Deaf was founded. In the United States the first recorded attempt to teach a deaf-mute was at Rowley, Mass. in 1679; but no account of what has been done in this respect would be complete without reference to the brilliant and infinitely painstaking work associated with the education of Laura Bridgman by Dr. S. G. Howe, head of the Perkins Institution for the Blind at Boston—an achievement which was praised

<sup>8</sup> *Encyc. Brit.* (14th ed., 1929) article "Education & Welfare of the Deaf and Dumb": the description of the method employed by John of Beverley is in *Bede's Ecclesiastical History*, Bk. V, cap. II, p. 225 of the "Everyman Edition."

<sup>9</sup> There are interesting references to Wallis in Defoe's *The History of the Life and Adventures of Mr. Duncan Campbell*, a deaf mute who was educated by Wallis's method; also there is a plate showing the finger alphabet (London, 1720).

<sup>10</sup> Dalgarno was "the first English writer to give the manual alphabet." *The Problem of the Deaf*, London, 1929, p. 18.

before her with the advantage of pronounciation, was much affected and taken therewith, and having the same Sermon afterwards presented unto her, when she came to read it, and found not the insinuations of elocution and gesture, gave her judgement of it, that it was one of the best Sermons she ever heard, and the worst she ever read" (p. 6).

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Dr. Helyn in his Geography, of a cold country where the Peoples Discourse doth freeze in the ayre all Winter and is heard the next summer or at a great Thaw; yet if the conceit of Walchius have any Truth, it may serve somewhat to extenuate the grosse absurdity of that Popish fable concerning Josephs Hah or the Noyse that he made (as other Carpenters use in fetching of a blow) which is said to be preserved yet in a glasse amongst other ancient Reliques" (pp. 48-49).

At times he is not without a sly humour as when, mentioning the sounds which the deaf are capable of making he comments: "Insomuch as he who to avoyde the inconvenience of Domesticke tempests should marry a Dumbe Mistress, may perchance speed no better than Seignior Moroso did with his Silent woman."<sup>14</sup>

It is not evident that he carried his ideas of teaching the deaf and dumb into practice but that they remained in the theoretical stage. If this is so it may then be true that someone else, for example Wallis or Holder, must be given the credit for the practical application of their methods. This would seem to be borne out by a passage in *Philocophus* where he says: "Nevertheless heerin I shall not descend to enact particulars . . . referring the inward contriving of accommodations, and the method of operation to our intended Academy."

### PATHOMYOTOMIA

*Pathomyotomia*, his fourth published work (1649), is well summarized on its title-page: "A Dissection of the significative Muscles of the Affections of the Mind. Being an essay to a new Method of observing the most Important Movings of the Muscles of the Head, as they are the nearest and immediate Organs of the Voluntarie or Impetuous motions of the Mind. With the Proposall of a New Nomenclature of the Muscles."

The writer of one of the very few articles dealing with Bulwer has well expressed the merits of the conception herein set forth. "It is perhaps not too much to say that, neither Lavater in his great work on physiognomy, nor Bell in his Anatomy of Expression, manifested that lofty conception of the subject with which each dealt that Bulwer did. With him Physiognomy and Expression, even when the latter was restricted to its connection with the Fine Arts, were the natural off-shoots of a wide-extending idea so fertile in its application and results, that the latter are still far from being exhausted. Doubtless, from the imperfect state of anatomy in Bulwer's time, he, in elaborating and applying his idea, fell almost as far short of success as Bacon did, when that great philosopher endeavoured to practise the method he so admirably taught. Yet, we think, that had an idea as pregnant and as philosophical as the one which guided Bulwer, influenced Lavater and Bell, when, with pen and pencil, they sought to give definiteness to our knowledge of the outward manifestations of the mind, their works would have possessed a higher and more abiding interest than they now possess."<sup>15</sup>

Let us hear what he himself has to say of the "Scope and Use of the Essay for some previous satisfaction to the Intelligent Readers".

"Having resolved to trace the Discoursing Actions of the Head to their spring and Principle upon which their outward signification depend, when I had passed the superficial parts, and digged a little more than skin-deepe into the Minerall of Cephalicall Motion, I came to the Muscles, the instruments of voluntary motion; or the instruments of those motions that are done by an earnest affection, that is, from an inward principle . . . Here I made a stand; and began curiously to enquire and hunt after all the anatomists both Ancient and Moderne that had writ of the muscles and the motions of the Head, as well to satisfie my self as to crave in ayde of them; and having had a view of as many as I could heare of and conveniently procure, and observed their severall veines and Methodicall variations no way answering my expectation; an emergent thought suggested to my imagination a notable Defect, hitherto undiscerned in that Art which of late hath attained unto a great perfection, which cast me into an extasie of admiration at so strange a preterition, that among the Conscript Fathers of Anatomy, there hath not been any one who . . . had undertaken a general survey and Cognomination of the Muscles of the body, as they are the necessary Instruments of all those motions of the Mind, which are apparently expressed and made manifest by the effect of their use and moving in all the parts of the Body, although more Emphatically, by those operations they have in the Head and the more remarkable parts thereof." Not even Galen in his "excellent Commentary *De Motu Musculorum*, wherein he went beyond himself, and shewed the greatest miracle of his wit, a Booke which all Anatomists kisse with

<sup>14</sup> Morose in Ben Jonson's *Epicoene, or The Silent Woman*.

<sup>15</sup> "A Medical Psychologist of the Seventeenth Century", *Jl. of Psych. Med.*, ed. by Forbes Winslow, M.D., 13, July, 1860.

enthusiastically by Charles Dickens in *American Notes*,<sup>11</sup> and to the equally remarkable case of Helen Keller and her teacher, Miss Anne Sullivan. Mention should also be made of Alexander Graham Bell, inventor of the telephone, who opened a school in Boston for training teachers of the deaf in 1872, and devoted much of his life to the welfare of the deaf.

Bulwer, like other innovators, had his critics: "The attempt to bring relief to men born deaf and dumb", he says, "is a thing so far beyond any man's conceits, that they looked upon him as some Utopian Montebank who first pretended to this Art; a simple pride and a shallow fate, having been ever the Nurses of Ignorance which is the cause of scornful laughter; many men being of that temper, that because they cannot conceive how it can be done, therefore, it cannot be done, as if all invention were limited within the narrow sphere of their capacity" (pp. 138-139). "For Deafness and Dumbness being privations and negatives, we can easier say what you cannot do than what you can."

It is curious that Bulwer with the cases of "Master Babington" and others in mind, and after his extensive studies of the movements of the hand in *Chirologia* and *Chironomia* did not also think of the method of speaking on the fingers.

He had, as we have seen, noticed the capacity which some of the deaf have for "Dentall Audition" and of being able to appreciate music through the medium of the teeth.

He gives examples of how the idea arose that the deaf were not so entirely shut off from communication as had been supposed. "A pregnant example", he says, "of the officious nature of the Touch in supplying the defect or temporall incapacity of the other senses we have found in one Master Babington of Burntwood in the County of Essex an ingenious Gentleman, who . . . becoming deaf, doth notwithstanding feeble words, and as if he had an eye in his finger, sees signs in the darke; whose wife discourseth very perfectly with him by a strange way of Arthologie or Alphabet contrived on the joynts of his Fingers; who taking him by the hand in the night, can so discourse with him very exactly; for he feeling the joynts which she toucheth for letters by them collected into words, very readily conceives what she would suggest to him" (pp. 106-107).

It appears from this quotation that there was but a step to be made from his desired objective of teaching deaf-mutes to the further one of educating the blind and of teaching them to read? Although Bulwer went far afield in his reading—and this is especially exemplified in the *Anthropometamorphosis*—he does not seem to have noted what was being done in that direction—or the information may not have been available. Contemporaneously—in 1640—"a writing master in Paris cast a moveable leaden type for the use of the blind. Pins inserted in cushions were next tried, and large wooden letter."<sup>12</sup> But two centuries and a half had to elapse before the efficient teaching of the blind became widespread. The first book for the blind produced in the United Kingdom was by John Gall, of Edinburgh, in 1827. Louis Braille (1809-1852) published his system in 1829 and developed it further five years later.

Of lip-reading Bulwer mentions that Fabricius has given an account of himself and how he practised this when speech was interdicted in class by the schoolmaster; that Lodovicus Vives tells of some Artists who used this method of communication; of "an Ancient Doctor, Gabriel Neale, who could understand any word by the mere motion of the lips"; and of "Mr. Crispe . . . whose dexterity in perceiving the meaning of men by the motion of their lips, is very well knowne to Merchants upon Exchange" (pp. 52 and 177).

He is convinced, therefore, that "articulate speech doth not necessarily assist the audible sound of the voyce, but may consist without it, and so consequently be seen as well as heard:" and that hearing is "nothing else but the due perception of motion". He appears to have realized that the speech mechanism was only functionally in abeyance; and that, as in the ordinary individual, education was necessary before speech was acquired. "Intelligence", he says, "comes to most before the strength of the Tongue."

Bulwer quotes from certain writers who give a sort of fantastic anticipation of the phonograph (or gramophone), or perchance of the radio! He speaks of Walchius "who thinks it possible intirely to preserve the voyce or any words spoken, in a hollow Trunke or Pipe, and that this Pipe being rightly opened, the Words will come out of it in the same order wherein they were spoken"; and of "Baldassar Castilio in his *Courtier*,<sup>13</sup> and

<sup>11</sup> Chap. III.

<sup>12</sup> *Encyc. Brit.* (14th edn.), article "Blindness." Still earlier Cardan had evolved a method for teaching the blind by the sense of touch, "not very different from the modern invention of Braille," Garrison, *History of Medicine*, p. 210.

<sup>13</sup> Baldassare Castiglione (1478-1520), author of *Il Cortegiano* (1514).

of the muscles appointed to the Eyelids: of those which serve to expresse the significations of the Mind exhibited by the motions of the Eye: of the muscles assigned the Eares: motions of the Nose, Cheeks, Lips & Mouth, Tongue."

He rather quaintly describes his procedure under the name of "dissections" using the term in the sense of examining carefully part by part, not in the ordinary anatomical sense.

For example, in one of his "dissections" he discusses laughter. "In profuse laughter", he says, "the motions that appear in the Face are very remarkable, there being not any particle of the Face that is moveable, but is moved by common or its particular muscles which lye under the skin of the Face whose actions introduce so notable a change and alteration in the Countenance, whence it is, that man onely laughs; because he hath a Countenance furnished with Muscles to declare what is signified thereby. In other Creatures the Face, or Muzzell rather, is dull and heavy, and seemes to sleepe in an immoveable habit: Not but that other Creatures are stirred up after their manner to expresse some signes of exultation and Delight, which supply the place of laughter: but because they doe not, as we doe, change the Countenance they are not said to laugh" (p. 104). "In this Dance of the Muscles performed by excessive Laughter upon the Theater of Mirth, the Countenance, the Mouth seems to lead the Chorus; for Laughter is a motion arising chiefly out of the Contraction of the Muscles of the Lips, in which Motion of the Mouth, called Laughter, the parts about the mouth seem bounded out with certain lines called Rictus, whence Risus" (p. 106). He passes in review the movements of the features brought into play during laughter in the course of which he remarks: "In laughter there is made, by reason of the Contranision, a certain corrugation or wrinkle about the angle of the eye, especially the outward angle, which in those that laugh often are supposed to grow habituall; which some Ladies fearing, will not laugh, lest they should contract wrinkles and looke old by breaking in that part which is neere the Temples" (p. 119). One wonders if he is wholly serious here!

Of the Eyes, "The Eyes of Man are the most cleare Interpreters of the affections of the mind: wherefore since for that purpose to be endued with a voluntary motion, and all motions are performed by muscles, therefore the Great Architect gave muscles to the Eyes, whereby they are most swiftly moved according to the inward motions of the mind. . . . If you would observe the proper motions of these muscles (when they remaine in their seat) bind a thread to every one of them not far from the tendon, and then draw it, and you shall see how each muscle works the eye to that motion which exhibits the signification of the mind which it was ordained to promote" (p. 166). An interesting and practical observation this which would assuredly have commended itself to Bacon.

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reverence . . . doth not so much as glance at it . . . nor in his Dissection of Muscles not a word, scarce, pointing to this Intention".

It is, he says, "More strange yet, that no Artists should have made this the Subject of their Orations, but should have all to this Day, either turned their discourse to the structure only of the Humane Fabrique, the perfections of Symmetry of the Body, or the excellency and antiquity of the Anatomique Art, or the Encomiums of the Antient and Moderne Anatomists". It does seem to have been a long time before this suggestion was followed up by anyone. Indeed like so many ideas it appears that a rebirth was necessary: for Sir Charles Bell when he wrote his *Anatomy of Expression* (1806) had apparently, as already noted, no knowledge of what Bulwer had already done, nor when, later, he produced his Bridgewater Treatise on *The Hand* (1833) did he know of the "Chirosopher" and his *Chirolgia*, as far as I am aware; but even after so many years had elapsed Bell admitted that: "It is not an easy task to reconcile two subjects so far apart in the minds of most readers as Anatomy and the Fine Arts."<sup>16</sup>

Bulwer deals with his subject in a methodical manner. The "Introduction to the Dissection of the Muscles of the Affections of the Mind" comprises the "Philosophie and general notions of voluntary motion". In the course of this he points out that a "muscle is the proper and adequate Agent of the voluntary and pathological motions of the mind, outwardly expressed in the Body. . . . The nearest and immediate instrument to the Motive Faculty for the exercise of motion . . . is a Muscle: from whence moving proceeds, as from a Motor, whence among Physitians it is reciprocal and Convertible, to move and to have muscles. . . . All the outward expressions we have or can make are performed by motion, and therefore signifie the affections of the mind, which are motions: the moving of the-instruments and parts answering in a kind of semblance and representative proportion, to the motions of the mind" (p. 4).

He describes the "nature and constitution of muscle", stating that the parts which are associated in its construction are "seven in number, to wit, a veine, Arterie, Nerve, Flesh, Tendon, Membran, & Fat": adding that "the prerogative of moving a Muscle is most justly given to the Nerve, which has its beginning in the brain": and the "Braine is the Universall Organ of Volutarie Motion". (With regard to the action of a muscle it is interesting to see that he adds: "The distinction of Spigelius is worth the noting: that motion can scarce any way properly be said the action of a muscle: but rather a certaine effect, and the use of its action: for the motion is of the part into which the muscle is inserted": and of the function of the nerve: "when the Palsie hath seased on any part . . . the most efficacious or strongest Appetite or Will cannot procure a motion, and if you bind a Nerve hard with a cord you may command what you will, but there followeth no obedience of the muscle whose Nerve is so stopt, since all notice or intelligence of our will is thereby intercepted from arriving at the Muscle" (p. 18). Such observations as these are sufficient in themselves to show that Bulwer had endeavoured to base his theories on such practical information as was then available.

In discussing the question: "that it is strange but not so wonderfull that Animal motion should be performed on such a sudden" he seems to come near to the idea of reflex action, though it would appear that he actually does not conceive other than voluntary acts. But he goes on to say: "all admiration and astonishment will vanish away, if we suppose that which is most certaine, to wit, that the motive faculty while man is awake, or not oppressed with heavy sleep, doth perpetually flow & travell to the nerves" (p. 24). It is rather to repetition (canalization) that the rapidity of later acts is due, "For Nature, as Vallesius well observes, never orders anything to have a power, only to move once: but she once gives that which shall have a power to move many times. And therefore when we attempt any second motion, we have the benefit of that influence which had first inabled the motory parts" (pp. 24-25).

These passages are from his *Introduction to the Dissection of the Muscles of the Affections of the Mind: in apparent significations exhibited by the Head . . . comprising the Philosophie and generall notions of voluntary motion*. He then proceeds to his main text: "An Essay to a new way of describing the operative and significative muscles of those Affections, which are more Conspicuously emphaticall in the Demonstrative Action of the Head and Face." He starts with the head as the "most eminent and obvious part, wherein the whole man seems to dwell" (p. 39), pointing out that the cervical muscles that "are set over the conduct of the Neck, accomplish the common motions of the Head" (p. 43). He deals in detail with these movements and how they are produced by the particular muscles. The Sectional headings give a good general idea of this: "General expressions and most important motions of the Face or Countenance: Of the muscles appertaining to the Forehead and the Browes or Eye-browes:

<sup>16</sup> Introduction to *The Anatomy & Philosophy of Expression as Connected with the Fine Arts*, by Sir Charles Bell (1806).

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as to divide them into Sects" (p. 54). In the same connection he speaks of this "Vesalian Deception" and of the "abhorred Solecisme of Vesalius".

Finally he has this modest—but moving—passage. "I am not ignorant that such daring attempts and undertakings are very obnoxious to envy, and apt to fall under the Censure of Arrogancy and ostentation, imputations I have no reason to feare, since I arrogate not to myself by the conduct of my owne light to have found any new or great thing to add to the Doctrine of Muscular Motion, to which (to speake the truth) there cannot be much added: neither am I so conceited of these animadversions as to hope they should be admitted into the Schoole of Anatomy, and straightway be made Canonical. . . . I have adventured far with little strength, and lesse encouragement to recommend the Designe to men of stronger Braines and publique Spirits. I think I may with modesty suppose that I have sprung a new veine, and say that I was enforced to dig my way through, and out of much Care and Drosse, to refine what was fit for my purpose, before I could come to ransack this secret and undiscovered treasury of the Muscles; or to cast the old metall of their matter into a new mold, to make it more illustrious by conjoyning it with the inward motions of the mind. . . . If they are contented to allow me to have bin the first that by Art endeavoured to linke the Muscles and the Affections together in a new Pathomyogamia. . . . I aske no more."

#### CONCLUSION

As there has been, so far as I am aware, nothing in the shape of a separate article on Bulwer for many years, I hope that I may be excused for going rather far afield and for trying to gather together the scattered references to him. It is significant that these are mostly to his *Artificial Changeling* rather than to his more valuable work from the strictly scientific point of view.

It is not, I think, too much to say that he was a remarkable man and that he has suffered undue neglect. He is in the true Baconian line, and a not unworthy disciple of that great master. In the wide scope of his reading he may fairly be placed beside the omnivorous Burton (1577-1639) whose contemporary he was and of whom I have heard Saintsbury remark that he had read everything that it was possible for a man to read—in a day when such a thing was possible. The latest edition (the 5th) of the *Anatomy* to be published during his lifetime appeared in 1638. I think that he would have appreciated Bulwer's various learning, in some ways akin to his own; and probably the *Anthropometamorphosis* would have appealed to him most. Be that as it may Bulwer knew the *Anatomy*, as one might expect, for he quotes, in his *Chirologia*, a passage from Burton's description of "Love Melancholy".

William Wadd in his *Nugæ Chirurgicæ*<sup>17</sup> has an amusing—even if slighting—reference to Bulwer that he was the author of many books, the most curious of which were his *Anthropometamorphosis* and *Pathomyotomia*. "We might conclude he was of Irish extraction: St. Patrick, the old song says 'ne'er shut his eyes to complaints', and Bulwer in *Instructions to the Deaf and Dumb*, tells us they are intended to bring those who are so born to hear the sound of words with their eyes!"

There is much we should like to know about Bulwer the man but the queries will probably remain unanswered—as, indeed, they have done in the case of others, for instance, Shakespeare of whom little actually is known, and to whom Bulwer makes no reference.

One wonders if he practised his profession as a doctor, or if he was of independent means, and thus able to devote his time to his literary and scientific studies;<sup>18</sup> if he was married—though some of his comments on women rather indicate that he was not; if he had a library or, if not, where he consulted the many books which he laid under contribution; where he lived, in town or country—his references to the "Sheep Pens in Smithfield" and the "Fish Dialect of Billingsgate" seem to suggest that he was familiar with London.

On the positive side it is evident that he was an industrious scholar and a learned man with a large vocabulary (part of which suggests that he was innovator in that direction also), and that he had a comprehensive knowledge of the classics. It was, of course, a period when men had to be scholarly and to know Latin and Greek, if their reading was to be extensive—though it was also a time when the translators, such as North, Philemon Holland, and Florio, were also industriously occupied. His reading and his learning were not, however, merely those of a pedant: he had—according to his lights, and sometimes they were illuminating ones—a definite scientific purpose. He studied the

<sup>17</sup> London, 1824, p. 188.

<sup>18</sup> It is interesting to note in this connection that he speaks of "a Physitian feeling the pulse of the arteries" (*Chironomia*, p. 103).

hand and all its movements in *Chirologia* and in *Chironomia* with the result that there emerged the idea, embodied in *Philocophus* of his Academy for the Deaf, and incidentally of the use of the movements of the hand to provide a universal language.

In *Pathomyotomia* he comes more definitely to grips with the underlying psychological phenomena, thus furnishing another example of the words of Professor Singer that: "it is perhaps in the department of psychological speculation that the influence of Bacon has been most marked." It will be remembered that Bulwer describes this book as a "Dissection of the Significant Muscles of the Affections of the Mind": and in it he does seem in his own words, "to have sprung a new vein". But to deal adequately with this little book one would need an extensive knowledge of all the earlier anatomical writers—though Bulwer appears to have covered the ground satisfactorily, as even a casual reference to the volume will show. He looked beyond the mere structural, anatomical aspect of the subject to a consideration of function and causation and to the "affective" or mental background.

In *Anthropometamorphosis*, his best-known and most popular work, he appears still to have the idea of "Anatomia Comparata" in mind but applied in the anthropological, or rather ethnological, sphere: and as a result he has written a not unimportant chapter in the history of mankind. Despite his too ready acceptance of "travellers' tales" he did produce an interesting comparative study of "customs, manners, habits, and fashion". With this interesting and entertaining book I hope to deal on another occasion—especially as it formed for me, as it seems to have done for others, an introduction to Bulwer. For, as he said: "When all is done somewhat must be left to observation; and if it be matter of oversight in the cursory reading of some Histories, then my Reader hath an opportunity to oblige me by a more happy invention and application: yet prudent omissions have their places, and an universal forestalment of a Readers fancy or memory is one of the four and twenty properties of a moyling Pedant."<sup>19</sup>

It may well be that if Bulwer had been able to write or publish the other books of which, apparently, only the titles remain, he would have completed his system of treatment of the deaf and dumb. It would be interesting to know what he intended to say in his tractates *De removendis Loquelæ Impedimentis* and *De removendis Auditionis Impedimentis*; in *Vox Corporis: of the Morall Anatomy of the Body*; and in his other projected works. It seems obvious that he intended to pursue his investigations into the psychological aspect of the matter: for, as he said earlier: "It cannot but be some disparagement to one that pretends to any ingenuous Education or Reading to be a meere Puppet or Mathematicall motion, and not to understand why, or after what manner, the muscles of his Head move in obedience to the Command of his Will: and so to have no better a Head-piece than that which counterfeiting the naturall motions of Speech, uttered its mind to Thomas Aquine, and the learned Frier Bacon."<sup>20</sup>

His list of published works is quite short; but all of them are now rather difficult to find and some of them are rare. They are as follows:—

- I. & II. *Chirologia*, or the Naturall Language of the Hand: whereunto is added *Chironomia*, 8vo, 1644.  
(In the Surgeon-General's Catalogue, 2nd Series, there is a separate edition of *Chirologia*, 1644; and in the 3rd Series, another edition, 1648.)
- III. *Philocophus, or the Deafe & Dumb Man's Friend*, 12mo, 1648.
- IV. *Pathomyotomia, or a Dissection of the significative Muscles of the Affections of the Minde*, 12mo<sup>6</sup> 1649.
- V. *Anthropometamorphosis: Man Transform'd; or, the Artificial Changeling*. (This is the edition in 12mo, 1650; a second, quarto edition "illustrated with cuts" appeared in 1653 and was re-issued in 1654, as *A View of the People of the Whole World*).

He himself adds to this list the following titles of "Workes accomplished by the Authour, which he may be induced hereafter to communicate". As far as I can ascertain these never were published:—

- Chirethnicalogia*: or the Nationall expressions of the Hand.
- Cephalologia*: or the Naturall Language of the Head, being an Extract of the most noble & Practical Notions of Physiognomy.
- Cephalonomia*: or the Art of Cephalicall Rhetorick.
- Vox Corporis*: or the Morall Anatomy of the Body.
- The Academy of the Deafe and Dumb*: being the manner of operations to bring those who are so borne to hear the sound of Words with their Eyes, and thence to learn to speake with their Tongues.
- Vultus Criticus*: seu, Physiognomia Medici.
- Glossiarius*: Tractatus de removendis Loquela impedimentis.
- Otiarius*: Tractatus de removendis Auditionis impedimentis.

This is the whole list of titles as given in the advertisement leaf at the end of *Anthropometamorphosis*. The first five are mentioned as "Workes of the Author already published." It is much to be regretted that the others had a different fate.

<sup>19</sup> *Chirologia*, p. 171.

<sup>20</sup> *Pathomyotomia*.

as to divide them into Sects" (p. 54). In the same connection he speaks of this "Vesalian Deception" and of the "abhorred Solecisme of Vesalius".

Finally he has this modest—but moving—passage. "I am not ignorant that such daring attempts and undertakings are very obnoxious to envy, and apt to fall under the Censure of Arrogancy and ostentation, imputations I have no reason to feare, since I arrogate not to myself by the conduct of my owne light to have found any new or great thing to add to the Doctrine of Muscular Motion, to which (to speake the truth) there cannot be much added: neither am I so conceited of these animadversions as to hope they should be admitted into the Schoole of Anatomy, and straightway be made Canonical. . . . I have adventured far with little strength, and lesse encouragement to recommend the Designe to men of stronger Braines and publique Spirits. I think I may with modesty suppose that I have sprung a new veine, and say that I was enforced to dig my way through, and out of much Care and Drosse, to refine what was fit for my purpose, before I could come to ransack this secret and undiscovered treasury of the Muscles; or to cast the old metall of their matter into a new mold, to make it more illustrious by conjoyning it with the inward motions of the mind. . . . If they are contented to allow me to have bin the first that by Art endeavoured to linke the Muscles and the Affections together in a new Pathomyogamia. . . . I aske no more."

#### CONCLUSION

As there has been, so far as I am aware, nothing in the shape of a separate article on Bulwer for many years, I hope that I may be excused for going rather far afield and for trying to gather together the scattered references to him. It is significant that these are mostly to his *Artificial Changeling* rather than to his more valuable work from the strictly scientific point of view.

It is not, I think, too much to say that he was a remarkable man and that he has suffered undue neglect. He is in the true Baconian line, and a not unworthy disciple of that great master. In the wide scope of his reading he may fairly be placed beside the omnivorous Burton (1577-1639) whose contemporary he was and of whom I have heard Saintsbury remark that he had read everything that it was possible for a man to read—in a day when such a thing was possible. The latest edition (the 5th) of the *Anatomy* to be published during his lifetime appeared in 1638. I think that he would have appreciated Bulwer's various learning, in some ways akin to his own; and probably the *Anthropometamorphosis* would have appealed to him most. Be that as it may Bulwer knew the *Anatomy*, as one might expect, for he quotes, in his *Chirologia*, a passage from Burton's description of "Love Melancholy".

William Wadd in his *Nugæ Chirurgicæ*<sup>17</sup> has an amusing—even if slighting—reference to Bulwer that he was the author of many books, the most curious of which were his *Anthropometamorphosis* and *Pathomyotomia*. "We might conclude he was of Irish extraction: St. Patrick, the old song says 'ne'er shut his eyes to complaints', and Bulwer in *Instructions to the Deaf and Dumb*, tells us they are intended to bring those who are so born to hear the sound of words with their eyes!"

There is much we should like to know about Bulwer the man but the queries will probably remain unanswered—as, indeed, they have done in the case of others. For instance, Shakespeare of whom little actually is known, and to whom Bulwer makes no reference.

One wonders if he practised his profession as a doctor, or if he was of independent means, and thus able to devote his time to his literary and scientific studies;<sup>18</sup> if he was married—though some of his comments on women rather indicate that he was not: if he had a library or, if not, where he consulted the many books which he laid under contribution; where he lived, in town or country—his references to the "Sheep Pens in Smithfield" and the "Fish Dialect of Billingsgate" seem to suggest that he was familiar with London.

On the positive side it is evident that he was an industrious scholar and a learned man with a large vocabulary (part of which suggests that he was innovator in that direction also), and that he had a comprehensive knowledge of the classics. It was, of course, a period when men had to be scholarly and to know Latin and Greek, if their reading was to be extensive—though it was also a time when the translators, such as North, Philemon Holland, and Florio, were also industriously occupied. His reading and his learning were not, however, merely those of a pedant: he had—according to his lights, and sometimes they were illuminating ones—a definite scientific purpose. He studied the

<sup>17</sup> London, 1824, p. 188.

<sup>18</sup> It is interesting to note in this connection that he speaks of "a Physitian feeling the pulse of the arteries" (*Chironomia*, p. 103).

## Section of Physical Medicine

President—P. BAUWENS, M.R.C.S., L.R.C.P.

[May 19, 1943]

### Some Observations on the Adaptation of the Double Beam Cathode-ray Oscilloscope to Biology and Medicine

By G. E. DONOVAN, M.Sc., M.B., D.P.H.

THE cathode-ray tube is becoming increasingly used as a recording device in the fields of medicine and biology.

Although the single beam oscillograph suffices for most medical problems, a still greater field of usefulness is opened up if we have two beams in the one tube. The double beam cathode-ray oscillograph removes the one remaining excuse for the moving mirror type of oscillograph which is retained by some workers for the facility of examining two traces simultaneously. The electronic switch is an alternative method of showing two patterns on one screen simultaneously, but it is more complicated and more expensive than the double beam system. Owing to the fact that the double beam cathode-ray tube has two spots capable of independent deflection in the vertical direction, whilst being deflected simultaneously in the horizontal direction by a common time base, it permits the direct visual simultaneous observation of two phenomena such as a phonocardiogram and electrocardiogram. On the other hand, the disadvantages of the double beam tube are comparatively slight. The brightness of each beam is less than the brightness of an undivided beam, also it is impossible to employ push-pull deflection to the Y plates. A fact to be borne in mind is that when the same signal is applied to both Y plates, the beams are deflected in opposite directions and not in the same direction. This apparent phase reversal can be easily compensated for by an extra stage of amplification for the deflection of one of the Y beams.

Bio-electrical quantities can easily be amplified and demonstrated in oscillographic form on the screen of a cathode-ray tube; also non-electrical quantities such as changes in pressure, brightness of light, temperature, &c., can be converted into potential variations, suitable for the oscillograph. Changes in pressure can be converted into an electrical equivalent by a piezo-electric device; brightness of light by means of a photo-electric cell and temperature through the medium of a thermopile.

The bio-electrical quantities or the equivalent potential variations of the physico-mechanical quantities are amplified by a vacuum tube amplifier whose over-all characteristics are such as will amplify the wave form without distortion or if desired, distortion can be deliberately introduced so that certain wave-form components can be accentuated or eliminated. The output of this amplifier can be used to control the Y, deflector plate of the double beam cathode-ray oscilloscope, and this controls the movements of one of the pair of cathode-ray beams in the vertical or Y axis. A similar amplifying channel can be used to amplify the electrical equivalent of the second phenomenon and this can be similarly demonstrated by the vertical movements of the second beam of the cathode-ray tube.

If desired, the wave form of both traces can be directly observed and this is done by making both beams move slowly across the whole of the cathode-ray oscilloscope in the horizontal or X axis, from left to right. This movement is given by a time-base circuit which supplies both beams. The circuit of the time base should be such that the pair of spots have a slow linear motion in relation to time. The principle used is simple, viz. the method of slowly charging a condenser through a pentode valve and automatically discharging it through a gas-filled triode; the constant current characteristic of the pentode ensuring a linear time base.

Various forms of cathode-ray screens are available. These may be roughly classified as (a) a blue screen which has high actinic qualities and is very suitable for photographic recording; the afterglow is practically absent; (b) a type of screen which gives an instantaneous blue-green light and whose afterglow is green. The instantaneous response is highly actinic and the afterglow, though giving a trace which lasts several seconds, is

## NOTES

With regard to the controversy as to whom credit is due for the inception of the treatment of deaf-mutes, Mrs. Dorothea Singer has kindly called my attention to the claim made on behalf of Pedro Ponce by Benito Geronimo Feijoo (1676?-1764) in his *Cartas eruditas* and also in his *Teatro critico*.<sup>\*</sup> He complains that the Spanish discoverers have been neglected in Spain and are prophets without honour in their own country: among others Pedro Ponce, "inventor of the admirable art of teaching the Dumb to Speak . . . and which appeared since as the production of John Wallis, a famous professor of mathematics in the University of Oxford". In another place Feijoo refers again to Pedro Ponce as the discoverer and adds: "Certain foreigners have appropriated, or sought to appropriate, for themselves the glory of so prodigious a discovery. It is true the first robbery in this matter took place inside Spain, committed by Juan Pablo Bonet of Aragon on the Benedictine Castellano. . . . Since then there marched forth for the rapine of this glory the famous English Mathematician John Wallis, the Swiss doctor Jean Conrad Amman, and the Portuguese D. Juan Pereyra"; and again: "From Paris to Amsterdam and Amsterdam to Paris they were bombarding each other as to who was the discoverer of the Art without anyone agreeing on Fr. Pedro Ponce, who was undoubtedly the man."

But it would appear that even Pedro Ponce was preceded by Cardan. And what of John of Beverley? It is obvious that he actually carried out the teaching of a deaf-mute in a practical manner.

It will be interesting to have the results of Dr. Douglas Guthrie's researches into this question of priority upon which he is at present engaged.

In an article on "The Genesis of Ideas in the Blind Deaf Mute" by Mrs. Burnet in the *Journal of Psychological Medicine* (Vol. VIII, p. 222, 1882) reference is made to Bulwer as saying: "But most miserable are they who are deaf, dumb, and blind." Mrs. Burnet, who wrote from Crimplesham Vicarage, Downham Market, adds: "Ecclesiastical writers report that one, Amagildus, who was both deaf, dumb, and blind, was restored to all his senses whilst he prayed unto St. Julian!" (The exclamation mark is hers.) She refers also to a case to be found in *Governor Winthrop's Journal for 1637*.

In a paper read by Dr. Eichholz at the Conference of Teachers of the Deaf, London, 1925, note is made of John of Beverley. "Rudolphus Agricola, born in 1442 at Groningen in Holland, mentions as within his knowledge the fact that a deaf-mute had been taught to write and to note down his thoughts." He refers to Cardan, Pedro Ponce, and Bonet: and adds: "The art appears to have died away in Spain, but was taken up by Englishmen. In 1648 Dr. John Bulwer published his *Philocophus*." *The Problem of the Deaf*, London, 1929, p. 18.

<sup>\*</sup> For the translation of the relevant passages I am indebted to Mr. G. D. Hornblower. They are from *Cartas eruditas y curiosas*, Madrid, 1777, Vol. III, p. 318; Vol. V, p. 243; and Vol. IV, p. 92.

Here are a few examples. Phenomena such as nerve action potentials, immediate heat generated by muscle, transparency of tissue, mechanical vibrations, &c., can readily be demonstrated singly or in pairs on the screen of the double beam cathode-ray oscilloscope. If desired, several traces can be shown simultaneously on two or more double beam cathode-ray oscilloscopes.

The double beam cathode-ray oscilloscope allows the stimulus to be registered by one of the beams and the reaction by the other, for instance, if the retina of a conger eel is stimulated by intermittent light, the discharges in the optic nerve can be registered by the upper trace of the double beam cathode-ray oscilloscope and the stimulus, i.e. the intermittent light can be transformed into an electrical equivalent by means of a photo-electric cell, which amplified is registered by the lower beam.

A practical application of the multiple recording of nerve action potentials is electroencephalography. On account of the low frequencies involved, ink writing recorders and cathode-ray oscilloscopes fitted with long afterglow screens are steadily gaining favour in this field. The single beam tube, due to the several recording channels required, is rather a cumbersome method, but a couple of double beam tubes overcome this difficulty. A rate of traverse of five seconds for the time base is satisfactory for the demonstration of the electrical variations of the brain. The double beam cathode-ray oscilloscope has the advantage over the ink-writing recorder that it allows the apparatus to be used in other fields of biology and medicine.

Muscle action potentials are assuming a greater diagnostic significance in the investigation of certain neuromuscular affections. Recently there have appeared articles by various workers showing the advantages of the method in this field. Multiple recording helps in the accurate localization of the lesion.

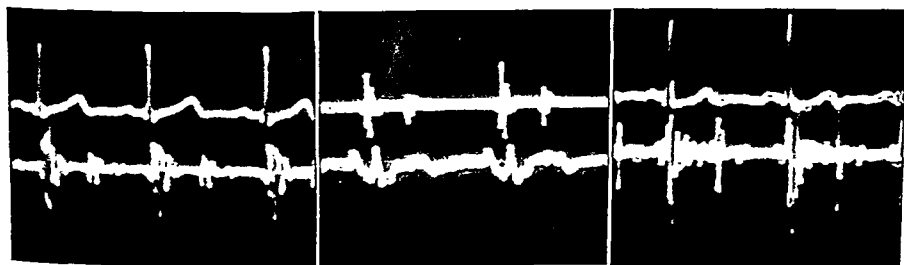


FIG. 2.

FIG. 3.

FIG. 4.

FIG. 2.—Simultaneous electrocardiogram and phonocardiogram as they appear on the screen for direct visual observation.

FIG. 3.—Simultaneous phonocardiogram and jugular pulse trace as they appear on the screen for direct visual observation.

FIG. 4.—Simultaneous electrocardiogram and phonocardiogram from a case of rheumatic mitral disease as they appear on the screen for direct visual observation.

The author (1943a, 1943b) has shown elsewhere some of the uses of the double beam cathode-ray oscillograph in cardiology. It is necessary in the graphic registration of the heart sounds that at the same time as the phonocardiogram, some other manifestation of cardiac activity must be recorded to provide a reference tracing. The electrocardiogram is generally used for this purpose. Modern technique enables one to demonstrate easily these two phases of cardiac activity. The double beam cathode-ray oscilloscope fitted with a long afterglow screen permits the direct visual observation of this pair of phenomena without the necessity of photographic registration. Nevertheless, the electrocardiogram as a reference tracing is not ideal in many ways as the electrical manifestations of the heart's activity are not of necessity synchronous with the mechanical events. Of course, the beginning of auricular excitation (rise of the P-wave) and of ventricular excitation (beginning of the QRS complex) are connected with the mechanical activity of the heart. It is becoming increasingly realized that the venous pulse gives a more satisfactory reference tracing. This pulse can be converted into an electrical equivalent by adapting a piezo-electric microphone for the purpose and artificially increasing the time constant by placing a large condenser in parallel with it. This allows the venous pulse to be recorded by an all-electric method and the phonocardiogram can be demonstrated as a trace on the fluorescent screen of the double beam cathode-ray oscilloscope, whilst appearing simultaneously under it is the jugular pulse tracing. By the use of two microphones and two channels of amplification, the sounds



only faintly actinic. [This was the type of screen used by the author for his demonstration]; (c) a green screen which gives an instantaneous response which is peculiarly suitable for visual observation but the afterglow is too short to render it useful for such slow phenomena as the direct visual observation of the electrocardiogram; (d) a red screen which gives a red response lasting for several seconds and which is suitable for slow phenomena. Probably the best screen for biological and medical work is the blue-green one as it permits both direct visual observation and the photographic registration.

Although the facility of immediate direct visual observation of a pair of phenomena such as the phonocardiogram and electrocardiogram makes the double beam cathode-ray oscillograph a valuable instrument, it is still important for the research worker and physician that permanent photographic records should be easily taken. There are two methods of photographically registering the traces, viz. (a) by focusing a camera on the fluorescent screen of the double beam cathode-ray oscilloscope and photographing the traverse of the pair of spots as they appear for visual observation, opening the shutter at the beginning and closing it at the end of the traverse of the spots. Because of the curvature of the screen, the lens fitted to the camera should be of short focal length so that the whole surface of the screen is in focus; (b) if permanent records are required as a routine, it is preferable to use a camera working with moving film and with the spots centred in the X axis so that the vertical movements of the spots become strictly comparable with the movements of the string of the string galvanometer. As the afterglow

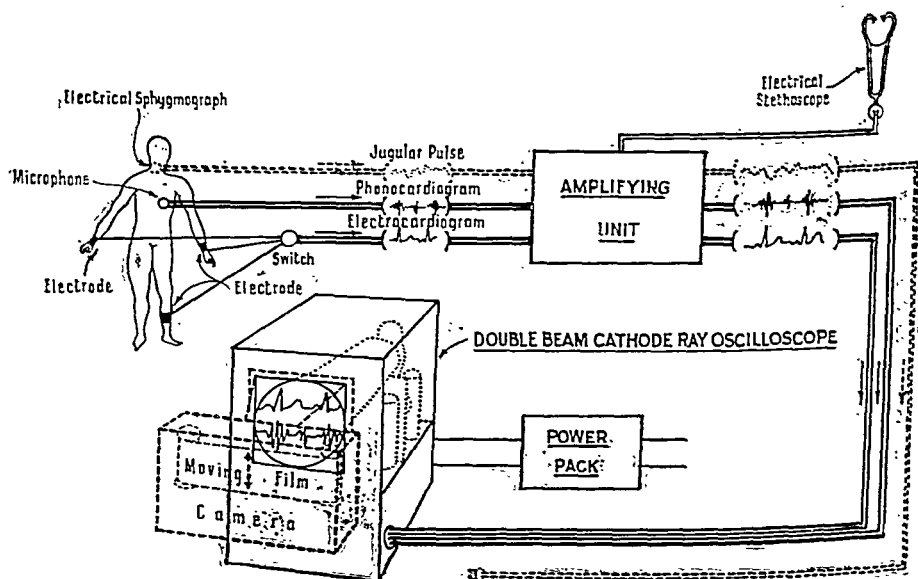


FIG. 1.—Schematic diagram of a clinical apparatus using the double beam cathode-ray tube fitted with a long afterglow screen, as the recording device.

of the spots compared with the direct response, is not sufficiently actinic, the traces on the photographic film will not be fogged. Where direct visual observation is not required as routine, and where the photographic recording is of paramount importance, the double beam cathode-ray oscilloscope fitted with a blue type of screen is the one of choice. The photographic film to work with this type of screen should be chosen so that it is mainly responsive to the blue end of the spectrum: this will allow the film to be developed with the aid of a safety light.

The double beam cathode-ray oscilloscope has the advantages from the point of view of the medical worker in this field, that the various factors are under his control. The brilliance and focus of the spots can be varied at will, the speed of the traverse of the spots in the horizontal direction across the screen is readily varied; the length of the traverse in this direction is adjustable; the oscillations in the vertical or Y axis can be regulated with ease. The effect of the foregoing is that the traces on the screen can be made optimum from the point of view of the operator.

Here are a few examples. Phenomena such as nerve action potentials, immediate heat generated by muscle, transparency of tissue, mechanical vibrations, &c., can readily be demonstrated singly or in pairs on the screen of the double beam cathode-ray oscilloscope. If desired, several traces can be shown simultaneously on two or more double beam cathode-ray oscilloscopes.

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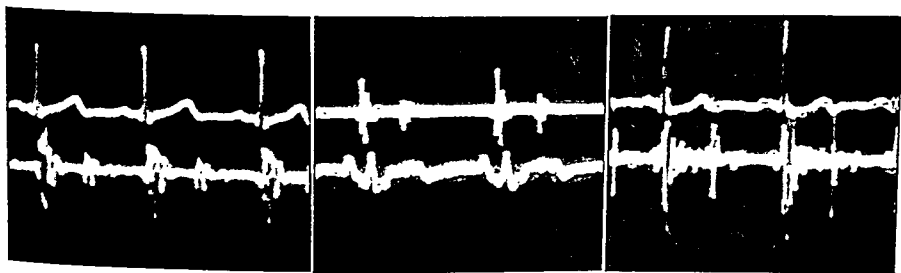


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over one area of the heart can be instantaneously compared with that of another. The effects of tone controls can be immediately seen, &c.

The rate of propagation of the pulse is of value in assessing the elasticity of the arteries. The hot wire sphygmograph has been used for this purpose; simultaneous records being taken of the central pulse and also the peripheral. In latter years a photo-electric plethysmograph has proved its usefulness in recording the blood-flow through a peripheral part. The variations of blood-flow cause changes in intensity of a beam of light which is being transmitted through the part. These changes in light are converted into an electrical equivalent by a photo-electric cell which can be amplified and demonstrated in oscillographic form. If an electrocardiogram is recorded as one trace of the double beam cathode-ray oscillograph and the amplified output of the electrical variations of the photo-electric cell is recorded by the second beam, the rate of propagation of the pulse can be estimated.

The piezo-electric manometer has been used by American workers (Macleod and Cohn, 1941) for studying intracardiac pressure and at the same time the simultaneously recorded intracardiac electrograms. The double beam cathode-ray oscillograph lends itself readily for the recording of these phenomena.

The foregoing are only a few examples of many, and, in conclusion, I would like to stress the usefulness of the double beam cathode-ray tube for demonstration purposes, clinical work and research.

[The main points of the lecture were illustrated by a practical demonstration.]

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## The Mechanism of Valgus Foot Strain

By E. J. CRISP, M.B.

UNTIL the mechanism producing valgus foot strain is better understood treatment will remain unsatisfactory, and the invariable prescription of foot class exercises and faradic foot baths lead to many disappointments.

In its early stages valgus strain, occurring in a normal foot, is easy to remedy, but when it becomes complicated by failure of the normal toe function, restoration becomes extremely difficult.

The primary cause of valgus strain is fatigue of the tibialis anticus. This highly important muscle supports the long arch during weight-bearing and progression, and holds the foot dorsiflexed when it is off the ground as in stepping forward. In its former action it is assisted by the tibialis posticus and in the latter by the extensor digitorum longus (fig. 1).

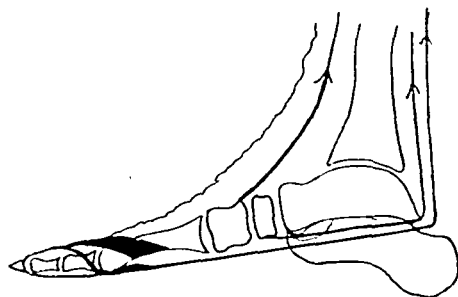


FIG. 1.—The normal muscle action during weight bearing. The tibialis anticus assisted by the tibialis posticus is supporting the long arch: the intrinsics are holding the toes straight on the ground, and the long flexor tendon is acting as a sling for the metatarsal head (after Lambrinudi); the long extensor of the toes is relaxed.

Among the contributory factors responsible for its breakdown are faulty posture, adolescence, overweight, and in the Army, heavy boots and long route marches. Failure of the muscle leads to flattening of the long arch during activity, though when off the ground the foot is still supported and dorsiflexed by the extensor digitorum longus.

Pain results from stretching of the plantar fascia. Rest in bed until this is relieved, followed by correction of posture, re-education in walking and re-training of the tibialis anticus, will be the only measures necessary.

Failure to recognize and treat the condition at this early stage frequently results in gross deterioration. The tibialis anticus becomes completely suppressed and the extensor digitorum longus tries to mimic its action as supporter of the long arch (fig. 2). All it

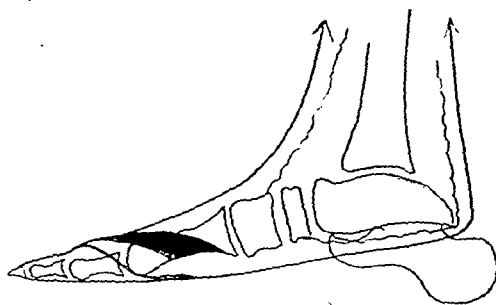


FIG. 2.—The extensor digitorum longus mimicking the action of tibialis anticus. The tibialis anticus and posticus have both ceased to act; the long extensor of the toes is contracting simultaneously with the long flexor; the intrinsics are shown still functioning.

succeeds in doing, however, is to interfere with the normal function of the toes. In progression the toes are held straight and firmly on the ground by the combined action of the flexor digitorum longus and the intrinsics, the former muscle also acting as a sling for the metatarsal heads. For its proper operation this mechanism is dependent on the relaxation of the extensor digitorum longus during weight bearing. Its contraction at this moment produces an unphysiological situation; the extensors and flexors are contracting simultaneously, with the intrinsics attempting to keep the toes straight and prevent deformity occurring. Something has to give way, usually the intrinsics, and as a result clawing of the toes and dropping of the transverse arch are added to the simple valgus strain (fig. 3). The extensor digitorum longus which is now contracting both when the

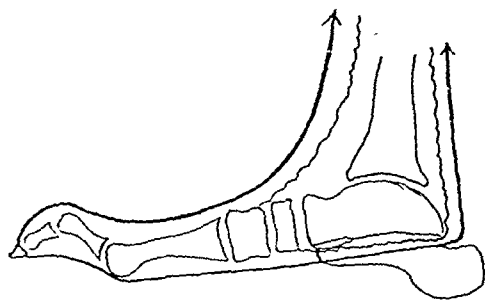


FIG. 3.—Failure of the intrinsics and clawing of the toes. Showing how the simultaneous contraction of the long flexor and the long extensor, uncontrolled by the intrinsics, produces clawing of the toes; note that the sling effect of the long extensor tendon is lost and that the weight falls directly upon the metatarsal head. The intrinsics are not shown; the tibialis anticus and posticus are shown relaxed.

foot is weight bearing and off the ground, goes into spasm and voluntary relaxation becomes impossible. The toes are held fixed, being hyperextended at the metatarsophalangeal joints and flexed at the interphalangeal joints, and the condition persists indefinitely, the individual being powerless to correct it. Soldiers with this disability have often been suspected of malingering, but in actual fact it is a deformity which is difficult for the normal foot to imitate, and impossible to maintain for any length of time.

This kind of muscular inco-ordination is extremely hard to rectify. Unless the masseuse can persuade the patient to relax, train him to dissociate the tibialis anticus from the extensor digitorum longus, and teach him to contract the former muscle, any further treatment will be a waste of time; for until these conditions exist the intrinsics will be unable to resume their normal function. Surging faradism applied simultaneously through separate leads to the intrinsics and the tibialis anticus is often a most useful agent in re-education, but the process is lengthy and requires great patience. Many cases will be found lacking in the necessary muscle sense and in due course adaptive shortening of the extensor tendons will produce the final picture of pes valgus with claw toes. When this stage is reached tenotomy may become necessary.

## Some Observations on the X-ray Treatment of Ankylosing Spondylitis

By GWEN HILTON, M.B., B.S.

WE began to use the X-ray treatment of ankylosing spondylitis at University College Hospital three years ago, and have treated 62 patients, 60 males and 2 females. In order to evaluate the results, I first classified the cases radiologically according to the location and extent of the changes observed:

- (1) Sacro-iliac changes only, 15 cases;
- (2) Spinal changes in addition, without ankylosis, 23 cases;
- (3) Spinal changes in addition, with partial ankylosis, 15 cases;
- (4) Spinal changes in addition, with complete ankylosis, 1 case.

But this was not satisfactory because the X-ray appearances do not necessarily bear any relation to the severity of the disease: for example, the clinical disease has often existed for some time before any visible bony or other changes can be detected, while, on the other hand, symptoms may have been of short duration and the radiological signs may be comparatively advanced.

A further point is that the X-ray appearances do not assist one to assess the results of the treatment since they appear to be irreversible.

I have, therefore, also classified the cases according to the length of history. I have divided the series into three stages:

- (1) Cases of less than one year's duration (11 cases);
- (2) More than one year and less than three years (17 cases);
- (3) Those with symptoms for more than 3 years (34 cases).

So rather more than half of the patients had had symptoms for more than three years.

The course of treatment to the sacro-iliac joints and vertebral column consists of eighteen treatments.

*Technique of treatment.*—There are two methods of irradiation generally in use, the wide field or "bath" technique and the small field local application.

I use the latter because there appears to me to be various grave disadvantages to the wide field method in the treatment of spondylitis. In the wide field method large masses of tissue are irradiated and although the dose given on the skin is very small, I do not think it has been realized enough that the integral dose, i.e. the dose received by the whole volume of tissue, is large and causes considerable constitutional disturbances: at the present moment, much research work is being carried out on the integral dose and its effect on the whole body, and we have a lot to learn in this direction. It has been said that no damage can be done to the patient, but several patients I have known, who have been treated by the wide field method, have been made so ill that they have given up the treatment, and two women treated by this method elsewhere have had amenorrhœa ever since irradiation given several years ago. Some think that the constitutional effect is the object of the wide field method, but if the same good results can be obtained without such constitutional disturbances by more limited irradiation, I feel it is wiser not to irradiate the whole body.

The ill-effects from the small field local application to the spine are very slight. Some patients complain of transient nausea when the lumbar spine is being irradiated. Freyburg and others (1941) mention leukopenia following this technique. I have not had any such cases in my series.

To what extent can the benefit following irradiation be explained by the psychological effect of a new treatment? Many of the patients here discussed have had various forms of treatment with little or no improvement until X-ray treatment was added.

Some experiments by Freyburg and others seem to show that when lead screens are introduced to cut off irradiation without the patient's knowledge, no benefit resulted. When the screens were removed later, significant improvement followed. Moreover, I have frequently observed improvement in the section of the spine treated, without change in other parts of the body.

In order to gauge the effect of treatment, we kept records of the following observations: (1) Relief of pain: (2) alteration in range of movement: (3) alteration in general condition, such as quality of sleep and weight: (4) blood-count: (5) sedimentation rate: (6) radiological appearances.

In cases which responded, there was definite relief from pain. Partial relief might come during the course of treatment, but usually a week or two after the end of the course. Often complete relief did not come until after a second course given six or eight months

later. As the pain diminished, movements of the spine became freer. The degree of movement attained was dependent on the extent of ankylosis present. All movements were encouraged by massage and by muscular and breathing exercises. We found that the muscles in patients who had been cripples for several years or who had been immobilized for some time, were so weak that although they were not in pain, they were at first quite unable to use their limbs. I have installed a rowing machine in the ward, which I find is of considerable value in gaining the interest and co-operation of the patients. I would like to stress that physiotherapy given in combination with X-ray treatment is regarded as essential in obtaining good results.

As the pain diminished, their sleep improved and their general condition altered for the better, their weight increasing. It should be added that all patients were given iron for the anæmia which was almost invariably present.

*Sedimentation rate.*—We have followed the changes in the sedimentation rate after irradiation in the hope that it would help us to estimate the effect of the treatment. This hope has not been fulfilled. The sedimentation rate is taken at the beginning of the course and then at varying intervals afterwards. It has been said that if the patient responds to the X-ray treatment, the sedimentation rate falls. We have found in our series that if the sedimentation rate at the beginning of the course was high, in the region, say, of 30 to 70 mm. in the first hour, then it rose even higher and only began to fall many months later. For instance, in one case, the sedimentation rate at the beginning of treatment was 43 mm. in the first hour. Four months later it was 60 mm. in the first hour and later it dropped to 30 mm. in the first hour. The patient had, however, made steady improvement all along. If, on the other hand, the sedimentation rate was only slightly raised, it fell one to two months after the end of treatment, without a preliminary rise.

From this it would appear that the changes in the sedimentation rate after treatment are not always parallel to the clinical improvement. This is an interesting feature which will need further study. At any rate, it is, I think, already recognized that the severity of the clinical condition is not correlated with the change in sedimentation rate.

*Changes in radiograph.*—In no case in which changes in the sacro-iliac joints or vertebral column were present at the beginning of the course was there any improvement in the X-ray picture after irradiation. The X-ray did not change for better or worse over the period of observation. It is, of course, impossible for me to say at what rate changes were proceeding before treatment was begun.

Before discussing the results, here are some details of a typical case.

The history of the patient, aged 22, appeared to date from a fall on the back in January 1938. He had, however, no pain or symptoms in his back until December 1938, ten months after the fall, when his back again began to get stiff and he suffered severe pain. In March 1940, his left leg and hip also began to stiffen. He was treated with massage and ultraviolet light, which improved the leg and hip somewhat, but made no alteration to the back.

In December 1940 he was X-rayed for the first time, when spondylitic changes were seen in the sacro-iliac joints and particularly in the lumbar region.

On examination in February 1941, he was a cripple. He could only hobble with two sticks with a bent back, the back and hips being held in a state of partial flexion. He looked pale and ill, and severe pain prevented him from sleeping. Movement of the spine and hips was extremely limited.

X-ray treatment was given to the spine and hips, and massage and breathing exercises were also given. At the end of the course the general condition had improved. The patient was sleeping well and was free from pain. The range of movement of spine and hips had increased and the left leg could be straightened. He continued to make steady improvement. Six months later he was given a second course of treatment to his hips. A few months later, he was able to walk without sticks and returned to work. He has put on a stone and a half in weight, and now, nearly two and a half years after the treatment, he walks and moves well, and does full-time work in a munitions factory.

*Comment.*—Of the 62 cases, 15 have only been treated during the past six months, so I am not including them in the evaluation of results. Of the remaining 47 cases, 7 are completely free of pain and are leading active and normal lives. Of these, 4 had had symptoms for one to three years, and 3 had had symptoms for more than three years before treatment was begun. One had radiological changes in the sacro-iliac joints only, but the other 6 also showed changes in the lumbar and dorsal spine, so the majority were in Groups II and III of the radiological classification. 38 more patients have improved a great deal, and are now free from continuous pain, but still have occasional twinges in

various situations. Most of these are at work again. The few who are not, are among the more recently treated.

Since in some cases definite improvement has continued even up to two years after the end of treatment, it is impossible at present to assess what their final condition will be.

There were only two patients in the series who did not benefit from the treatment. One of these shows a hysterical hemi-anæsthesia, and the second did not attend regularly for the treatment.

The conclusions I draw from my observations so far, are that it is worth while treating any patient with ankylosing spondylitis, whatever the stage, except when there is complete ankylosis coupled with entire absence of pain. The treatment by the radio-therapist and physiotherapist in conjunction will usually convert the crippled patient into a useful citizen.

#### REFERENCE

FREYBURG, R. H., SMYTH, C. J., and LAMPE, J. (1941) Roentgen Therapy for Rheumatoid Arthritis of the Spine, *J. Amer. med. Ass.*, **117**, 826.

## Demonstration of Apparatus for Self-activated Exercises in the Early Rehabilitation of the Sick and Injured

By O. F. GUTHRIE SMITH, M.B.E., C.S.M.M.G.

As there is considerable confusion of thought between re-education of function, remedial exercises and rehabilitation, it seems desirable to review the use of these terms before proceeding to describe the apparatus.

In the early stages of the *re-education* of function the patient may require help either in the form of manual assistance by a physiotherapist or simple aids such as suspension-slings and pulleys. Such assistance calls for precise technique in order to localize the effort to the weak muscles and to upgrade the strength of exercise as function improves.

The Swedish system of *remedial exercises* is characterized by manual assistance or resistance in which the operator works on the patient rather than by teaching the patient to help himself; but this type of manual and individual treatment cannot be sustained for sufficiently long periods nor can it provide the tempo necessary to make a patient fit for strenuous occupations.

In *rehabilitation* the function of the physiotherapist is to teach the patient to carry out his own exercises, to understand the purpose of the work and to co-operate by stimulating mental as well as physical effort. To this end apparatus has been designed which is activated by the efforts of the patient or a group of patients working together, whilst suspension-slings and springs are employed to localize the muscle work and to give a predetermined degree of assistance or resistance; effort and rest periods alternate in rhythm.

The apparatus consists of a steel frame which can be used in a department ward or in the open air and may be regarded as a portable gymnasium. Steel springs graded by poundage from 10 to 50 lb. are used to provide "variable" resistance whilst slings permit of the suspension of the whole body or of one limb as required. The apparatus permits also of rope and pulley and pulley and weight "fixed" resistance exercises when desired. The advantages of the apparatus for obtaining self-activated exercises are that it provides a comfortable support and the patient is not afraid of movement; friction and the pull of gravity are eliminated. It permits of relaxation followed by "weightless" and rhythmical exercise. As function improves resistance is added and the patient's effort can be sustained for any desired period, till strong muscle work is achieved.

The clinical application of the apparatus may be illustrated by examples. In spastic paralysis excellent relaxation is obtained as a preliminary to re-education; in flaccid paralysis muscle work can be localized to the affected muscles and contraction of the antagonists eliminated. Progressive movement in painful arthritis or after injury can be obtained with a minimum of muscle work and with the patient confident that movement is under his own control. In orthopædic cases weight and counter-weight of the body itself are used to apply corrective force in deformities; mobility of joints can be maintained after manipulation and, by means of spring resistance, very strong muscle strengthening or "eutonic" exercises are obtained.

A film was shown to illustrate eutonic exercises after abdominal operations and typical exercises were demonstrated on the suspension apparatus.

[Eutonic is a name given to distinguish spring-resistance exercises from other forms of resistance.]

## Section of Dermatology

Chairman—H. C. SEMON, M.D.

[May 20, 1943]

**Acanthosis Nigricans with Discrete Warts and Marked Mucous Membrane Changes in a Patient with Vitiligo.**—L. FORMAN, M.D.

D. R., male, aged 33.

August 1941, gastro-jejunostomy performed by Mr. Spalding at the County Hospital, Farnborough, for growth of the pylorus with secondary deposits. Remained well except for occasional nausea and fullness after meals until last six months, when he complained of generalized itching which was worse on scrotum, under arms and on breasts.

On forehead the skin is thickened with some discrete flat warts. Filiform warts on lower lids. Warty masses at angles of mouth. Tongue normal. Teeth were removed several years ago. Warty thickening of epithelium of gums, showing interdental projections of the kind one would expect to see following recent extraction of teeth. Inside cheeks, velvety white thickening. At sides of neck, in axillæ, on nipples, around perineum and perianal regions, the skin shows the velvety thickening of acanthosis nigricans. Scattered over the inner aspects of the thighs and behind the knees there are discrete warts which are indistinguishable from infective warts.

He has had vitiligo as long as he can remember. It is interesting that no changes of pigmentation have occurred on previously depigmented areas, where the skin has undergone the thickening of acanthosis nigricans.

Levulose tolerance test: Fasting blood sugar per 100 c.c. 106 mg.; one hour after sugar 113 mg.; two hours after sugar 104 mg.

Blood sodium chloride per 100 c.c. 548 mg. (normal 560 to 620 mg.).

Blood sodium per 100 c.c. 315 mg. (normal 325 to 350 mg.).

Blood potassium per 100 c.c. 25 mg. (normal 18 to 21 mg.).

**Lupus Pernio.**—C. H. WHITTLE, M.D.

D. T., married woman, aged 41.

Bluish-red, painless swelling of distal end of nose one and a half years' duration, accompanied by loss of weight, as much as 1 st. in a year, and feeling below par. Swelling on right thumb one month previously; this was painless and it subsided leaving no mark. No lesions discoverable elsewhere. No palpable enlargement of glands or spleen.

**Comment.**—There is no tuberculous history. The X-ray of the chest and of the fingers is negative and the Mantoux test is negative in a dilution of 1:100, and only very weakly positive in a dilution of 1:10. Nose examined for active lupus vulgaris but none found. Diagnosis of vascular nævus has been suggested, but the Section will probably agree with the original diagnosis of lupus pernio.

**Dr. L. Forman:** I agree with Dr. Whittle. On compression one could see small lupus-like translucent nodules over the end of the nose.

**The President:** What treatment is proposed?

**Dr. Whittle:** So far such cases as I have had have done well with general ultraviolet light, and I am hoping that this will also do well.

**Major F. F. Hellier:** An alternative diagnosis is lymphocytoma. Such cases, although commonly more localized, may give a lesion somewhat of this character. A biopsy would be helpful to confirm the diagnosis.

**Alopecia with Scarring.**—C. H. WHITTLE, M.D.

R. F., a girl aged 15.

There is an area of alopecia about 3 in. diameter on the right parietal region. The total history is about three and a half years. There is scarring and reddening of some follicles, and the hair has shown very little tendency to regrow. Admittedly there are some



large hairs scattered about on the surface, but the lesion does not fit in with my original diagnosis of alopecia areata, given with confidence two years ago.

I should like the opinion of the Section as to whether this is one of the true scarring alopecias, or whether it may be an artefact produced by the habit of a nervous child rubbing and scratching the part. She had received ultraviolet light treatment on my advice.

**The President:** On examination there was no follicular enlargement and no scaling. I had the feeling that the patient had received X-rays at some time. Possibly together with this ultraviolet light treatment she was given X-rays.

**Dr. Whittle:** It is quite possible, but I was not guilty.

**Dr. Prosser Thomas:** The mother gave me a history which suggested that the child originally had a suppurative ringworm, and I thought the present appearance would do well for the end-result of a kerion.

**The President:** It is the sort of end picture one sees in some of the suppurative animal types of infection.

**Major F. F. Hellier:** The scarring may be lupus erythematosus. In a cicatricial alopecia one often finds a folliculitis but here I do not see any and there is not the appearance one finds in pseudopelade. I suggest a course of gold or bismuth.

**Major W. J. O'Donovan:** This is undoubtedly a defined circular lesion, truly scarred, there is a spider-web scarring throughout, and it is singularly pigmented. I cannot think it is an artefact. When asked if she had had X-ray treatment the patient said that she had, but her mother said it was ultraviolet light. Otherwise the localized atrophy and pigmentation are suggestive of lupus erythematosus.

### Three Cases of Reticulosis Cutis.—C. H. WHITTLE, M.D., and P. HUGH-JONES, M.B.

#### CASE I.—*Reticulosis Cutis: "Leukæmic" Erythroderma (homme rouge).*

R. H., a man aged 74, by trade a boot-repairer.

History of a rash for five years with intense itching, which of late has become less marked. Seen first in March 1943, he then presented bluish-red thickening of the skin generally, œdema of the face and particularly the eyelids, œdema of the penis and scrotum, and ankles, and some tendency to scaling.

**On examination.**—Axillary and inguinal lymph glands considerably enlarged and firm, mobile; spleen not palpable. X-ray of chest showed enlargement of hilar shadow suggesting enlarged mediastinal glands.

The skin had the usual "elephant-hide" texture, inelastic and thrown into coarse creases by the natural movements of the body. The face and extremities were moderately cyanosed and the palms of the hands showed deep cracks in the folds.

**Blood-counts.**—Moderate hypochromic anæmia and relative and absolute lymphocytosis. Total leucos. 36,000 per c.mm. Lymphos. 17,280 (48%), polys. 14,400, eosinos. 1,800, large monos. 1,800, neutrophil myelos. 180, blasts (? lymphoblasts) 360.

**Skin biopsy (shown):** A moderate cellular exudate in the papillary layer, chiefly small round cells and polymorphs; few plasma cells and histiocytes. This is not specially suggestive of leukæmia.

**Axillary gland biopsy (shown):** The general structure is masked or obliterated and the follicles have disappeared. The pulp is diminished and there is fairly marked increase of endothelial type cells; favours Hodgkin's disease rather than leukæmia.

**Marrow biopsy (shown):** No leukæmia apparent.

#### CASE II.—*Reticulosis Cutis: Mycosis Fungoides.*

C. G., male, a small-holder, aged 43.

First seen in November 1939 with two weeks' history of an eruption on the trunk, very itchy, erythroderma, reddish brown in colour. Enlarged glands in the groin: spleen not palpable. Family history of asthma.

**The eruption:** This had started between the shoulder blades and had extended rapidly over the greater part of the trunk, arms and legs, leaving the face, wrists, and lower legs untouched. It was raised, bluish-red, confluent with sharply-defined edges.

Wassermann reaction and blood-counts at the earlier stages were negative and normal respectively.

**Course:** The sheets of erythema broke up and the affected areas steadily diminished in size leaving deeply pigmented skin, without scarring. (He had had arsenic and general U.V.R. which may have accounted for the pigmentation.) Improvement continued, the itching ceased and he appeared to be getting well until November 1942 when he presented himself again with extension, more itching and enlargement of glands in the cervical, axillary and inguinal groups. He has been in and out of hospital

since, with remissions and relapses. Now the whole body is involved, but activity is diminishing.

Tumours have now been present four months.

**Blood-count.**—Shows normal red cells and hæmoglobin, with relative and absolute lymphocytosis of mild degree. Total leucos. 22,000 per c.mm. Lymphos. 6,600, polys. 12,210, eosinos. 1,760, monos. 880, blasts (? lymphoblasts) 550.

**Biopsy of skin tumour (shown):** Characteristic of mycosis fungoides, with abundant infiltration of the papillary layer of the corium with endothelial type cells, small round cells and plasma cells. Eosinophils few and mast cells few.

**Sternal marrow count (shown):** No lymphocytosis: some evidence of increase in immature cells of granular series.

**N.B.**—This case was shown at the meeting of the Section on April 11, 1940, when the diagnosis of mycosis was suggested by certain members and the skin biopsy showed an infiltrate resembling the type found in mycosis fungoides. (*Proc. R. Soc. Med.*, 1940, 33, 580; *Brit. J. Derm.*, 1940, 52, 261.)

### CASE III.—*Reticulosis Cutis: ? Early Hodgkin's Disease.*

H. A., male, a timber feller, aged 50.

History of one year generalized skin eruption, which started after three months' bouts of sweating following an abscess in buttock.

**Family history.**—Father and sister both asthma subjects.

The eruption is a fairly generalized erythroderma, bluish-red in colour with considerable thickening of the skin, and with many infiltrated dome-shaped tumours on the trunk which tend to break down in the centre and form abscesses. These are mostly about an inch in diameter. The skin shows a tendency to crack, but his condition has improved since admission. The tumours are preceded by a period of sweating and followed by severe itching.

Lymphatic glands enlarged and firm in the axillæ, groins, neck and epitrochlear regions: the spleen not palpably enlarged.

**X-ray of the chest:** No enlargement of mediastinal glands.

**Blood-count** shows no important departure from normal. Total leucos. 8,600 per c.mm. Polys. 6,450, lymphos. 1,120, monos. 260, eosinos. 770.

**Skin tumour biopsy (section shown):** The vessels are dilated and there is a moderate cellular exudate into the papillary layer, chiefly of small round cells and polymorphs. The centre is breaking down to form pus. There is a moderate eosinophilia.

**Axillary gland biopsy (section shown):** The structure of the gland is well preserved, but there is much increase of the reticular tissue, apparently chiefly endothelial cell hyperplasia, and patchy eosinophilia. Some doubtful Sternberg-Reed giant cells.

The picture is not diagnostic but is a little suggestive of early Hodgkin's disease.

**Sternal marrow count:** No significant departure from normal percentages.

	CASE I	CASE II	CASE III
Clinical diagnosis ...	"Leukæmic" erythroderma	Mycosis fungoides	? Hodgkin's ? mycosis
Total length of history ...	5 years	3½ years	1 year
Skin lesion ...	Diffuse infiltration	Typical mycosis—early tumour stage	Diffuse infiltration nodules (central softening)
Sweating ...	None.	None.	+ + for about 1 week, then "boils" come out, then irritation + + (cycle repeats)
Irritation ...	+	+ +	+
Family history ...	Allergy + + (asthma)	No allergy, "Skin trouble" +	Allergy + (asthma)
Lymph glands ...	All superficial groups + + chest + +	All superficial groups + +	All superficial groups + +
Spleen ...	Not +	Not +	Not +
Blood. Total whites ...	36,000	22,000	8,600
Lymphocytes ...	17,280	6,600	1,120
Eosinophils ...	1,800	1,760	770
Skin biopsy ...	Chronic inflammation. Oedema	Histiocytes + +. Small round cells +. Plasma cells +	Small round cells +. Polymorphs at centre (skin nodule)
Gland biopsy ...	Abnormal cells (not leukæmic)	—	? Atypical Hodgkin's
Sternal marrow ...	No leukæmia	No lymphocytosis. ? Increase in early granulocytes	Approximately normal percentages

**Dr. Whittle:** The second case was shown here about three years ago, when there was considerable discussion and the diagnosis of mycosis fungoides suggested. The last case is as yet undiagnosed. The cases have a clinical link with each other, and possibly a pathological one. We hope to publish fuller details later.

large hairs scattered about on the surface, but the lesion does not fit in with my original diagnosis of alopecia areata, given with confidence two years ago.

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## Sternal Puncture—Bone Marrow Smear (4.2.43).

Differential count on 400 cells:

	Neutrophil	Eosinophil	
Polymorphonuclears	34.25	10.0	} A
Metamyelocytes	6.25	—	
Myelocytes	18.75	5.75	
Prémyelocytes		4.50	} B
Myeloblasts		3.75	
Lymphocytes		10.75	
Large hyalines		0.50	
Normoblasts		0.25	} B
Erythroblasts		5.25	

The proportion of cells of the myeloid series (A) to nucleated red cells (B) is 17 to 1. Normal varies from 8 to 1 to 2 to 1.

*Histological report on biopsy of skin and lymph gland* (December 1942).—Skin: The epidermis is thinned and the interpapillary processes elongated. Extensive cellular infiltration of the subpapillary corium and to a lesser degree of the papillæ, consisting of: (1) Predominating, a cell resembling the plasma cell but, except for a few, failing to stain by Pappenheim stain and lacking the typical nuclear marking. A few of these have double nuclei. (2) Larger cells of the histiocyte class. (3) Lymphocytes. (4) Mast cells in moderate number. (5) Occasional eosinophil leucocytes. Some areas of nuclear degeneration are present. Dilated thin-walled blood-vessels are numerous and some oedema is present. Organisms can only be seen in the keratin on the surface.

Epitrochlear gland: The architecture is largely obliterated by heavy cellular infiltration of the medulla. A few compressed follicles are recognizable. The cells resemble those described in the corium. The plasma-cell-like type predominates and the histiocytes are also numerous, some of them contain hæmosiderin.

CASE III.—*Exfoliative Erythroderma with Leukæmic Blood Picture.*

E. C., female, aged 32. Occupation: Housewife.

History five years. Generalized irritation and changing colour of the skin with scaling. Colour was apparently brownish at first, then became red, and is now a bluish plum colour. Generalized oedema of the skin. Generalized adenitis. Possible enlargement of the spleen. W. R. negative.

*Blood-counts.*

Date	R.B.C.	Hb.	C.I.	W.B.C.	Polys.	Myelos.	Lymphos.
15.6.42	4,000,000	80%	1	9,000	6%	—	90%
30.6.42	3,200,000	64%	1	31,000	28%	—	57%
18.5.43:	Polys. 63.0%, eosinos. 2.0%, basos. 1.0%, monos. 12.0%, small lymphos. nil, large lymphos. 4.0%, primitive white cells 18.0% (? monoblasts) Embleton.						

Sternal puncture: Bone-marrow smear.

10.7.42: Smear cells 5.5%, lymphoblasts 9.5%, lymphos. (large) 43, lymphos. (small) 10, myelos. 2, polys. 26, eosinos. 3.5, normoblasts 19 per 100 white cells, megaloblasts 4 per 100 white cells.

There is a lymphatic increase, particularly of the large lymphocytes. The smear shows considerable activity of the polymorphonuclear series. This is compatible with an early lymphatic leukæmia.

*Histological report on biopsy from the forearm* (Dr. Vaux, 23.6.42): Diffuse and focal infiltration of the dermis with numerous lymphocytes and a few eosinophils and epithelioid cells. The appearance is compatible with a leukæmic erythroderma.

Lymph glands: The follicles are small. There is a great increase of lymphoid cells, both mature and immature, and also scattered eosinophils in the medulla as well as proliferation of reticulum cells. The blood-vessels contain a number of lymphocytes; fibrosis is present in some areas and a few small hæmorrhages. The picture is that of lymphoid medullary reticulosis.

It is considered that these cases belong to the same group as those demonstrated by Dr. Whittle and we intend to publish them fully, with comments.

**Dr. P. Hugh-Jones:** The pathology of these cases has not been fully worked out.

Case I was diagnosed as "leukæmic" erythroderma and he had a total length of history of five years. He has, unfortunately, died, and there has been a post-mortem examination. Clinically he seemed exactly like "leukæmic" erythroderma and his blood-count supported that view.

Case II is one of *mycosis fungoides*. The condition here gives rise to itching, and he is in the early tumour stage.

Case III has not yet been diagnosed and has only a year's history; there appears the same sort of skin infiltration, though he has a different and earlier type of skin nodule. He, himself, described the nodules as "boils", and it is true that they break down and give the appearance of boils.

I am able to show lantern slides of the skin sections from the cases. The first, which we describe as "leukæmic" erythroderma, shows a great deal of cell infiltration, but it is pathologically just a diffuse infiltration into the skin. The next case has been diagnosed definitely as *mycosis fungoides* and we think it will be seen that there is a much greater infiltration into the skin. It also shows a different type of infiltration—a number of histiocytes, some small round cells, and some plasma cells. It contrasts with the other two cases which show an infiltration of the skin suggestive only of chronic inflammation.

Thus, although these cases really do show a very definite clinical resemblance, the skin sections are different.

As you will have seen they all have much skin irritation. In the last case this is of a cyclical type: the patient has sweating for a week, then the "lumps" in the skin come out, then the irritation becomes intense, and after that the cycle repeats itself.

There is a history of allergy present in the "leukæmic" erythroderma, which may or may not account for the eosinophilia which one sees in the blood-films.

The lymph glands are all enlarged in each case, and in the "leukæmic" erythroderma case there is very marked enlargement. It will be seen from the blood-counts that in the "leukæmic" erythroderma there is a pronounced lymphocytosis. All the cases show an increase in the white cells, though this in the last case, which had only a year's history, is not so marked.

The case which we confidently diagnosed as "leukæmic" erythroderma, and which died, showed at post-mortem no signs whatever of leukæmia. There were abnormal cells in the bone-marrow but these were certainly not leukæmic.

### Three Cases of Exfoliative Erythroderma.—J. E. M. WIGLEY, M.B.

#### CASE I.—*Exfoliative Erythroderma (Reticulo-endotheliosis).*

S. T. W. T., male, aged 59.

History six months. Intense irritation; yellowish red colour of thickened skin with generalized exfoliation. There was cervical, axillary, and inguinal adenitis, and also some enlargement of liver and spleen. W.R. negative.

#### *Differential Blood-Count.*

Date	R.B.C.	Hb.	C.I.	W.B.C.	Polys.	Lymphos.	Eosinos.	Monos.	Basos.
27.3.43	—	—	—	11,900	36%	32%	26%	5%	1%
12.4.43	4,960,000	85%	0.9	13,700	66%	21%	11%	2%	—

Biopsy of skin: Reticular proliferation and parakeratosis.

Biopsy of gland: Irregular reticular proliferation and eosinophilia. "Consistent with Hodgkin's disease."

#### CASE II.—*Exfoliative Erythroderma with Leukæmic Blood Picture.*

E. S., male, aged 57. Occupation: Coal miner.

History three years. Generalized irritation, redness and scaling of the skin, which is thick and oedematous. There is cervical, axillary and inguinal adenitis. The liver is enlarged two fingerbreadths below costal margin and feels smooth. The spleen is not palpable. Ascites developed within past three months. W.R. negative.

X-ray of chest: Enlargement of hilar shadows. Probable silicosis of lungs.

Gastric analysis: Complete achlorhydria.

Gastroscopy: Some degree of atrophy of gastric mucous membrane. No other lesion seen.

#### *Blood-counts.*

Date	R.B.C.	Hb.	C.I.	W.B.C.	Polys.	Eosinos.	Lymphos.	Primitive
23.11.42	4,630,000	74	0.8	19,800	48%	11%	33%	1%
30.11.42	4,300,000	76	0.88	42,600	45%	14%	32%	6%
25.1.43	3,710,000	73	0.98	23,900	54%	14.5%	26%	0.5%
7.5.43	4,040,000	75	0.93	16,400	63%	13.5%	20.5%	—

nodules had appeared for some weeks. No treatment has so far been carried out, and involution has been entirely spontaneous.

No glands palpable but spleen extends two fingerbreadths below the costal margin. Blood-count normal.

Wassermann reaction negative.

*Comment.*—Anyone who has not seen the section from one of this patient's lesions, as well as the more active clinical phase, might reasonably doubt the diagnosis. Kaposi's disease is more rare in women than men. There is no evidence of any continental ancestry in this woman, whose parents both came from East Anglia.

Spontaneous involution is, of course, one of the features of this disease, although in some cases, such as one I showed here with Dr. Roxburgh in 1938, involution only occurred after deep X-ray therapy. This treatment, however, did not prevent the development of new lesions subsequently, and I have little doubt that further lesions will develop in this case with or without such treatment.

In addition to the other unusual features already described in this case, the condition is still unilateral two years after its onset, whereas in all the cases originally described by Kaposi, and most of those observed since, there has been some degree of symmetry. Amputation seems unjustifiable since there appears to be no record of the disease ever having been aborted by excision of the earliest lesions.

#### REFERENCE

ROXBURGH, A. C., and KLABER, ROBERT (1938) *Proc. R. Soc. Med.*, 31, 878.

#### Idiopathic Hæmorrhagic Sarcoma of Kaposi.—J. E. M. WIGLEY, M.B.

Mons. D., aged 75. Of Southern French stock though he admits possible Italian ancestry.

About one year's history. Some stiffness of hands and bleeding on trauma are the only symptoms.

Lesions present on the left auricle, about each wrist, on the back of each hand and fingers and on the sole of each foot.

The lesions include bluish macules, thickened plaques of a blue and brownish colour. Nodules of varying size, both hard and soft and many telangiectases are present. Some of the nodules appear "let in" to the surrounding tissues like a wax mould. There is some oedema of the hands but no ulceration. The general health is good and the W.R. negative.

*Histology.*—A section from a well-marked lesion on one hand shows two well-defined nodules in the corium. The nodules consist of interlacing bundles of spindle-shaped cells. Spaces indicative of newly formed vessels are present on the periphery of the nodules. Between the nodules are many newly formed vessels and dilated spaces. Much iron pigment is present. Otherwise there is little change.

*Treatment.*—One exposure of 250 r to the hands about three weeks ago has been followed by some diminution of the size and hardness of the lesions.

Dr. Klaber: The histology of Dr. Wigley's case is sarcoma of the spindle-cell type, which is the basis for Kaposi's original title of idiopathic hæmorrhagic sarcoma, whereas mine is of the angiomatous type, without any obvious sarcomatous cells. With regard to treatment, spontaneous involution is one feature of this disease, although in some cases involution only occurs after deep X-ray therapy. This treatment, however, does not prevent the later development of new lesions.

Dr. F. Parkes Weber: Does anyone remember one of Dr. Sequeira's typical cases of so-called multiple hæmorrhagic sarcoma? In the case I have in mind the patient developed a rapidly growing true sarcoma in the left leg and there could be no doubt that that growth developed on the hæmorrhagic sarcoma; it was spindle-celled. It behaved like a malignant tumour, and recurred in the stump after amputation (see J. H. Sequeira and R. T. Brain, *Brit. Journ. Derm.*, 1926, 38, 501).

Major W. J. O'Donovan: I recall this case well; it was exactly as Dr. Parkes Weber has described it. I wonder whether Dr. Klaber would agree with me that clinically he might suspect a melanotic carcinoma if he had not determined his diagnosis by the histological report?

#### Early Kraurosis Vulvæ in a Child.—J. E. M. WIGLEY, M.B.

H. W., aged 7.

First sent to hospital in October last year on account of constipation. At that time her mother stated that she seemed to suffer from considerable itching about the anus and vulva and that the mother noticed "something unusual" about these parts for some

**Dr. C. H. Whittle:** I agree with Dr. Wigley that all these cases belong to the group of reticulo-endotheliosis, and therefore one should expect all shades of variation between different clinical types. Sequeira and Pantón have published records of 5 cases in 1925 (*Quart. J. Med.*, 18, 250). One of them was originally described as parakeratosis variegata (Dore, S. E., *Proc. R. Soc. Med.*, 1922, 16, Sect. *Derm.*, 19); the term used up to then was lymphoderma perniciosum but that was deliberately abandoned by Sequeira and Pantón in their description. Their paper shows clearly certain important points. These cases, which correspond very closely to Dr. Wigley's "blue-red" patient and to our "homme rouge" who died, and to a number of other cases shown from time to time at this Section are clinically distinct, as Sequeira and Pantón were at pains to point out, from other cases of erythroderma such as we get with Hodgkin's disease, and mycosis fungoides and also from cases due to drugs such as arsenic, and from cases of generalized psoriasis and eczema. Again they are not really typical leukæmias. In the British literature few, if any, of the cases described as "leukæmic" erythroderma are really leukæmias at all. There is little post-mortem evidence and some of it is not conclusive. In the case details and sections we saw to-day of our case of "leukæmic" erythroderma, the post-mortem evidence definitely excludes leukæmia in spite of a blood-count of 36,000 total white cells of which half are lymphocytes.

Is there any sort of conclusion which we can come to without going further into the histology? We have to emphasize the distinction between this group and the true leukæmias. My impression of the leukæmias is that they do not get erythroderma as a rule but they get discrete separate tumours.

Another point is that this type of generalized erythroderma is fairly commonly associated with Hodgkin's disease, and very probably some of the doubtful cases will prove in time to be cases of that condition. The mycosis group before the tumour stage has been reached shows more discrete lesions, with a tendency to "geographical" figures, with infiltration. This was true of our Case II which I showed three years ago and which has remained true to type, now showing tumours. Perhaps the whole problem will be cleared up by a careful study of lymph nodes, blood pictures and of sternal marrow punctures.

**Major W. J. O'Donovan:** What was the bone-marrow like in the recent post-mortem?

**Dr. Whittle:** It was not leukæmic marrow. The pathologist was not prepared to give a diagnosis of this case at post-mortem. The man had died of some intercurrent disease—pneumonia.

**Major Hellier:** The question of the little nodules formed in some of these cases is interesting. I remember a case very similar to one of them. It was under my care for some fifteen months in all and it went through various phases. At a certain stage the patient developed little tumours. I had a biopsy done of them, and I found intense polymorphic infiltration which I thought must be myelogenous leukæmia. We did a sternal puncture but it did not show very much. The patient had a raised polymorphonuclear count. After a period all these tumours settled down and ultimately cleared up entirely. I am quite satisfied that they were really infective lesions occurring in a damaged skin.

**Dr. L. Forman:** There is a large surface of inflammation in the skin and the blood is the medium for carrying white blood-cells to the skin. A white blood-count of 12,000 is often encountered without there being any evidence of either sepsis or any subsequent evidence of leukæmia.

**Major W. J. O'Donovan:** I might recall the most remarkable observation of the late Dr. Pernet who showed an association between these mycosis fungoides cases and longevity. The parents of the patient had reached a most ripe old age in every case he had seen, and I have found the same thing true in my own experience, that the longevity of the parents is phenomenal. I hope that Dr. Wigley will look into the longevity of the cases he has shown as this association of phenomena may be a factor in differential diagnosis.

#### Kaposi's Disease.—ROBERT KLABER, M.D.

Mrs. M. H., aged 32. In 1941 she noticed pain on pressure, middle inner aspect of sole of left foot and a slightly raised, purple, tender lesion appeared at this site. At the War Memorial Hospital, Enfield, X-ray photographs showed nothing abnormal.

September 1942: The lesion was curetted and a microscopic section taken in which only dilated vessels were recognized. The condition never healed completely and bled freely at intervals after the slightest trauma.

Referred to me by Mr. Cruickshank, with a small red bleeding mass about 1 in. in diameter. A section was requested but owing to excessive bleeding and the friability of the tissue, no material was obtainable. The whole was treated by diathermy and healed after a month, leaving only an irregular scar.

March 1943: A group of purple nodules appeared on the back and inner aspect of the ankle. These were raised and elastic in consistency. The appearances suggested Kaposi's disease and a microscopic section taken from one of the nodules appears to confirm this.

In the two months which have since elapsed, the purple nodules have become flattened and the colour has changed to mauve-brown. When last seen on May 5 no fresh

accept the condition as an active tuberculide in spite of repeatedly negative Mantoux reactions, or as an unusually active case of Boeck's sarcoid with secondary coccal infection.

**Dr. Parkes Weber:** I think that this is a fairly typical example of what I have called a rosacea-like type of cutaneous sarcoidosis (Weber and Lauber, *Proc. R. Soc. Med.*, 1939, 32, 1025), and all these microscopical examinations are not points against that diagnosis. Our case was that of a woman with a very similar condition of the face and in that case there could be no doubt whatever that it was a kind of sarcoidosis because, just before the rosacea-like condition developed, she had had a small typical "lupus pernio" of the nose, and the microscopical examination of a nodule on the right upper arm had shown sarcoid structure.

**Major W. J. O'Donovan:** If one wants to use a clinical term our predecessors would have called it a severe case of acnitis and have left it at that.

**The President:** I believe that by common consent the term acnitis is no longer used.

**Dr. Klaber:** I hope Major O'Donovan will forgive me if I fail to quarrel with his observation. I would, however, implore Dr. Parkes Weber to withdraw his suggestion. We have already had so much trouble with the "rosaceous tuberculide" that we should at all costs avoid a "rosaceous sarcoid".

### Poikiloderma of Face and Neck (Poikilodermie Réticulaire Pigmentée Civatte).—

THERESA KINDLER, M.D. (for Dr. R. T. BRAIN).

Mrs. A. M., aged 55. Menopause started five years ago. Nervous subject, otherwise well. Has had 8 healthy children, no miscarriages. No skin diseases in her family.

Eczema of backs of hands was treated and cured with X-rays. No X-ray treatment to any other part of her body. She had had some U.V.R. to her face, but long after the disease had started. She had been on the stage for many years and admits the excessive use of greasy cosmetics.

Changes in her skin were first observed eight years ago. The skin of her face was very red and scaly, but she does not exactly know where and how the trouble started. The condition became gradually worse, but remained confined to face, neck and adjoining regions. It was more marked in cold weather. Irritation slight.

**Present condition.**—Skin of face, neck and upper part of chest resembles an X-ray atrophy. Especially at the cheeks, chin, front and sides of the neck and behind the ears it shows a variegated appearance, a fine network of pigmentation and depigmentation, telangiectases, erythematous and atrophic spots; the pigmentations being more marked on the neck, the telangiectases and erythema on the face. In some parts there is infiltration, the skin is tense and adheres to the deeper layers. Round the mouth the skin is crinkled. The lids are slightly oedematous and show telangiectases. There was more scaling and irritation when I saw the patient first, but this improved after treatment with simple creams. The mucosa of the mouth is free.

**Histology.**—Epidermis is thinned to a few layers; rete cones and papillae mostly missing; border between epidermis and cutis a straight but not sharply defined line. Basal layer: intercellular oedema, cells swollen, vacuolized, nuclei shrunken. Papillary layer and upper part of dermis: not very dense infiltrate consisting of fibroblasts, lymph cells, chromatophores. Numerous dilated vessels surrounded by infiltrate. Elastic fibres shredded, rarefied, feebly stained; collagen transformed into homogeneous, feebly coloured bundles.

The occurrence of the disease, chiefly in women at the menopause, suggests a neuro-endocrine aetiology. On the other hand some workers, e.g. Thibierge and Habermann, identify it with melanoderma toxica, which is produced by contact with impure oils and greases. Also Civatte admitted eventually that those cases are similar, if not identical, with his own. As our patient admits the excessive use of fatty cosmetics over a very long period, the question arises if the chemical irritation from possibly impure fats was not an additional factor in the provocation of the disease.

Treatment is usually unsatisfactory, although Civatte claimed success in one case. We have tried simple creams, stilbæstrol and recently injections of antuitrin S, 100 units twice weekly.

### Poikiloderma Atrophicans Vasculare Jacobi.—THERESA KINDLER, M.D.

My other patient, W. R., is a man aged 57, whom I am showing as a contrast to the first case. He is suffering from the generalized type of the disease. The patient is married and has two healthy children. No family history of skin disease.

His skin disorder started fifteen years ago, after a serious motor accident in the course of which he suffered a compound fracture. The first sign was a red patch on



three years. The mother stated that she was a rather difficult child to manage and that she seemed shy and diffident.

The only past history which may be of interest is that there was some vaginal bleeding noticed for a short time after birth.

*On examination.*—The inner side of the labia majora appeared white and shiny, suggestive of atrophy, a few fine telangiectases were observed over the white area. There seemed little evidence of labia minora and the white atrophic-looking area appeared to surround the meatus urinarius. A similar appearance was noted spreading back towards the anus.

General physical examination of the child showed no obvious departure from the normal. A single threadworm which was found was suitably dealt with.

*Histology.*—A section taken from the vulval area shows some thickening of the horny layer. In the upper third of the corium there is œdema leading to rarefaction, even to a "fading away" of the connective tissue. The remaining bundles of connective tissue are caked together, giving a homogeneous appearance. In places there is a gap visible between the epidermis and the cutis. The elastic tissue is diminished, being absent in the more rarefied areas. Some cellular infiltration is present.

The general histological appearance is identical with that described as lichen sclerosus.

*Treatment.*—Treatment with an œstrin ointment (1,000 units per g.) has produced some improvement. The mother states the child's general condition has improved, she has less irritation, is easier to manage and seems more self-confident.

*Comment.*—Dr. Agnes Savill has called my attention to a case reported by Ketron and Ellis (Ketron, L., and Ellis, F. A., *J. Surg.*, 1935, 61, 635) referred to by her in the *J. Obstet. Gynec.*, 1942, 49, 310, of a child aged 8 which seems to me almost identical with this case, both clinically and histologically, under the title of "Leucoplacia". They appear to use this term synonymously with kraurosis vulvæ and discuss the similarity of this condition to scleroderma circumscripta. They do not appear to draw distinction between this latter condition and lichen sclerosus.

As the appearances in the present case seem primarily to be the results of an atrophic process I have preferred to record it under the name of kraurosis.

[Dr. Agnes Savill has written in to say that she prefers to call the case the "late contracted stage of leukoplakic vulvitis".]

**The President:** It might be that the condition is the result of scratching. The clinical appearances are common enough in adults and the middle-aged, but here we have a child of 7 in whom the same clinical picture is present.

**Major W. J. O'Donovan:** I confess that I have never seen a case like this before. I am surprised to hear that some colleagues have seen many such striking cases. Their non-appearance at large clinics calls for an explanation.

? Tuberculide, ? Sarcoid.—ROBERT KLABER, M.D.

T. E., married man, aged 31, apparently in good general health. Six months ago an eruption first appeared on the middle of his forehead, which his doctor regarded as "herpes". Within a few weeks the eruption had spread over the greater part of the face and ears.

Four months ago, the lesions consisted of firm, raised pinkish-red papules of varying size, on a dusky erythematous base, a small proportion being capped by a small pustule or adherent crust. On glass-pressure, some lesions showed a central translucence but none any typical apple-jelly nodules. He had not taken any bromides and there was no history of tubercle or syphilis. No palpable glands.

Total white cell counts ranged from 13,400 to 14,800 per c.mm. without any special preponderance. Wassermann and Kahn reactions were twice negative, as were repeated Mantoux reactions. Radiographs of chest, hands and feet showed nothing abnormal. The E.S.R. was slightly raised, showing a fall of 14 mm. in one hour (normal 4 to 10 mm.).

Some improvement having followed a first injection of N.A.B. a total of just over 5 g. has been given over a period of ten weeks with considerable improvement. Numerous lesions, however, still persist.

A first biopsy taken before treatment began shows circumscribed inflammatory nodules, consisting largely of lymphocytes, with some polymorphonuclear cells. A later section shows well-marked tuberculoid granulation tissue with numerous giant cells.

*Comment.*—One would expect a late secondary syphilide to clear up completely after 5 g. of N.A.B.

The choice of diagnosis in this case is not easy. It would seem that one must either

accept the condition as an active tuberculide in spite of repeatedly negative Mantoux reactions, or as an unusually active case of Boeck's sarcoid, with secondary coccidial infection.

**Dr. Parkes Weber:** I think that this is a fairly typical example of what I have called a rosacea-like type of cutaneous sarcoidosis (Weber and Lauber, *Proc. R. Soc. Med.*, 1939, 32, 1025), and all these microscopical examinations are not points against that diagnosis. Our case was that of a woman with a very similar condition of the face and in that case there could be no doubt whatever that it was a kind of sarcoidosis because, just before the rosacea-like condition developed, she had had a small typical "lupus pernio" of the nose, and the microscopical examination of a nodule on the right upper arm had shown sarcoid structure.

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His skin disorder started fifteen years ago, after a serious motor accident in the course of which he suffered a compound fracture. The first sign was a red patch on

his left arm and the affection gradually spread over the greater part of his body. He felt intense irritation; later on the skin felt sore and became extremely tender to touch and pressure, so much so that even the touch of his clothes and bedclothes feels like "being rubbed with a sandpaper". He has felt increasingly weak and tired for many years and has been impotent for eight years. The symptoms are worse in winter.

On inspection the patient shows a symmetrical involvement of most of his integument. The changes are most pronounced at the sides of the trunk, the arms, thighs and buttocks and show large, ill-defined atrophic and erythematous areas with bright red or purplish marbling, net-like pigmentations, atrophies, telangiectases and small hæmorrhages. At the buttocks and back of thighs the skin is very thin, crinkled, scaling. On the buccal mucosa telangiectases are present.

The circumstances in this case, the onset after a shock, the weakness and impotence also make a connexion with neuro-vegetative and endocrine disorders probable. By some workers a suprarenal insufficiency has been suspected. The pains and weakness in the muscles also suggest an accompanying myositis similar to the type Petges-Clejat. Unfortunately we were not able to obtain a biopsy from the muscles.

The patient has been seen in several clinics and to exclude an infectious focus, all his teeth had been taken out many years ago; but the progressive deterioration continued. As all other treatments have failed, we intend to try suprarenal extract now.

The two types of poikiloderma have been regarded by some writers as varieties of the same syndrome, which seems to be confirmed by the very similar histology; others thought them to be different entities, Civatte's type being identical with melanoderma toxica Hoffman.

#### Annular Cutaneous Tuberculosis—H. J. WALLACE, M.D.

Unmarried woman aged 40, three lesions on the front of her left leg. The largest first appeared ten years ago and has been spreading slowly.

*Family history.*—The mother and father, two sisters, two uncles and one aunt, all developed pulmonary tuberculosis about the age of 40.

*Past history.*—Well until three years ago, when she developed German measles, with rheumatism as a sequel. She was in bed for four months and has not felt really well since, although she has no definite symptoms beyond lassitude.

*Investigations.*—Mantoux 1:1,000 positive. X-ray of chest: No abnormality detected.

*On examination.*—The lesions show a brownish scaly edge, the brownish colour being persistent on diascopy. Their centre bears a superficial resemblance to morphea and is traversed by telangiectases. No other abnormal physical signs detected on general examination.

*Histology.*—Chronic inflammation of the dermis. At one place there is a collection of cells comprising endothelial cells and a few giant cells. In another part there is a curious myxomatous-like change in the dermis. The condition seems to be compatible with tuberculosis.

*Major O'Donovan:* I would suggest that in addition to general light baths for this case of tuberculosis acutis local ultraviolet light therapy with a water-cooled lamp be used as well to shorten the time of treatment.

#### Idiopathic Macular Atrophy.—F. SHERRY-DOTTRIDGE, M.B.

A girl aged 11.

*History.*—For the past three years, small bright red patches have appeared on the extensor surface of the arms, shoulders and legs. There is no irritation. Some of the spots very slowly disappear, leaving colourless atrophic areas. There is no sign of scleroderma anywhere in the skin.

*On examination.*—Normal healthy child. No septic focus.

*Biopsy report:* The section shows hernia-like protrusions of the skin. The epidermis is thinned, cells are smaller than usual, basal cells flattened. Rete cones and papillae are missing and cutis thinned. Elastic fibres are present in the subepithelial layer, but almost absent in the upper and middle parts of the cutis. The few remnants are broken, thickened and partly arranged in bundles. The collagen is homogeneous, has lost its fibrous structure and colours badly. Infiltration, chiefly round the vessels and glands, consists of lymph cells, fibroblasts and plasma cells. Sebaceous glands are missing except for remnants but sweat glands can be seen.

I have to thank Dr. R. T. Brain for permission to show this case.

JOINT DISCUSSION NO. 7

# Sections of Otology and Laryngology

Chairman—F. C. ORMEROD, F.R.C.S.

(President of the Section of Otology.)

[June 4, 1943]

## DISCUSSION ON THE INFLUENCE OF VITAMINS AND HORMONES ON THE PHYSIOLOGY AND PATHOLOGY OF THE EAR, NOSE AND THROAT

Sir Edward Mellanby: I cannot claim any special clinical knowledge of otology but, in the course of my experimental work, some observations on the labyrinthine capsule and its contents were made which may serve as an introduction to this discussion.

There is at present no well-founded evidence that vitamin deficiency is an important factor in any of the clinical conditions found in Otology. This, however, cannot be regarded as a final judgment. We have as yet only scratched the surface of the subject of nutrition, and, in view of other facts, it would be strange if some important relations, at present unknown, between nutrition and morbid conditions of the ear, nose and throat did not come to light.

Had we been meeting seventeen years ago, my opening remarks would have been rather different. At that time we had discovered that otitis media could be produced with some regularity in rats by omitting vitamin A from the diet and we then felt that otitis media in children might also be related in some way to vitamin-A deficiency. Now we know that this is not the case. It was just unfortunate that the rat was chosen for this experimental work, since it reacts to vitamin-A deficiency in a particular way by developing epithelial hyperplasia, especially in the Eustachian tube, and this is generally followed by infection in the middle ear and in other places. As far as my knowledge goes, however, rats are the only animals so far tested that react in this particular way, and further experience does not suggest that children are similarly affected, even if their diet is very deficient in vitamin A. On the contrary, you have all seen otitis media develop in children whose vitamin-A intake is very high.

As regards the wider problem of vitamin deficiency, certain writers have said that if nicotinic acid or riboflavin or vitamin B<sub>12</sub>, &c. were cut out of the diet, defects in the hearing mechanism were produced, and if these substances were given to patients suffering from these conditions an improvement was forthcoming. But other investigators have been unable to confirm these results. Instead, however, of reviewing the literature I shall refer to some experimental work showing the effect of one nutritional factor on the labyrinth which although it may not have any clinical significance at the present time, will no doubt form the basis of future studies on man as well as on animals.

The story started many years ago when I was working on rickets. Some of the experimental animals became very inco-ordinated in their movements, a condition which was clearly not a part of the rachitic syndrome itself but evidently had an ætiological basis not far removed from that of rickets.

The differentiation of the original vitamin-A complex, first described by McCollum and Davis in 1913, into two constituents—now known as vitamin A and vitamin D—occupied scientists for a period of many years, and it was not until 1929 that vitamin D (the antirachitic vitamin) was obtained in a pure form, and this was followed in 1931 by the preparation of pure vitamin A. I had found however, some years earlier, by providing vitamin D alone in the form of irradiated peanut or olive oil and so preventing rickets, that the factor responsible in puppies, young rabbits and rats for the development of the severe inco-ordination was the absence of vitamin A. On examination of puppies thus affected it was found that both the cochlear and the vestibular divisions of the VIIIth nerve showed severe degeneration. Other cranial and peripheral nerves on the afferent side were similarly affected, including the optic, the trigeminal and afferent fibres of the spinal nerves. In addition, widespread degeneration was found in the central nervous system, more particularly in fibres of the posterior columns, and in both direct and indirect cerebellar tracts. Some descending tracts were also involved in the degenerative changes, including the vestibulo-spinal, the posterior longitudinal bundle and the rubrospinal tract. The pyramidal fibres were unharmed. There was also much degeneration in ganglion cells, both peripheral and central. This strange distribution of nerve degeneration in vitamin-A deficiency seemed to have neither rhyme nor reason, but its consistency and the similarity of the reactions

his left arm and the affection gradually spread over the greater part of his body. He felt intense irritation; later on the skin felt sore and became extremely tender to touch and pressure, so much so that even the touch of his clothes and bedclothes feels like "being rubbed with a sandpaper". He has felt increasingly weak and tired for many years and has been impotent for eight years. The symptoms are worse in winter.

On inspection the patient shows a symmetrical involvement of most of his integument. The changes are most pronounced at the sides of the trunk, the arms, thighs and buttocks and show large, ill-defined atrophic and erythematous areas with bright red or purplish marbling, net-like pigmentations, atrophies, telangiectases and small hæmorrhages. At the buttocks and back of thighs the skin is very thin, crinkled, scaling. On the buccal mucosa telangiectases are present.

The circumstances in this case, the onset after a shock, the weakness and impotence also make a connexion with neuro-vegetative and endocrine disorders probable. By some workers a suprarenal insufficiency has been suspected. The pains and weakness in the muscles also suggest an accompanying myositis similar to the type Petges-Clejat. Unfortunately we were not able to obtain a biopsy from the muscles.

The patient has been seen in several clinics and to exclude an infectious focus, all his teeth had been taken out many years ago; but the progressive deterioration continued. As all other treatments have failed, we intend to try suprarenal extract now.

The two types of poikiloderma have been regarded by some writers as varieties of the same syndrome, which seems to be confirmed by the very similar histology; others thought them to be different entities, Civatte's type being identical with melanoderma toxica Hoffman.

#### Annular Cutaneous Tuberculosis—H. J. WALLACE, M.D.

Unmarried woman aged 40, three lesions on the front of her left leg. The largest first appeared ten years ago and has been spreading slowly.

*Family history.*—The mother and father, two sisters, two uncles and one aunt, all developed pulmonary tuberculosis about the age of 40.

*Past history.*—Well until three years ago, when she developed German measles, with rheumatism as a sequel. She was in bed for four months and has not felt really well since, although she has no definite symptoms beyond lassitude.

*Investigations.*—Mantoux 1:1,000 positive. X-ray of chest: No abnormality detected.

*On examination.*—The lesions show a brownish scaly edge, the brownish colour being persistent on diascopy. Their centre bears a superficial resemblance to morphea and is traversed by telangiectases. No other abnormal physical signs detected on general examination.

*Histology.*—Chronic inflammation of the dermis. At one place there is a collection of cells comprising endothelial cells and a few giant cells. In another part there is a curious myxomatous-like change in the dermis. The condition seems to be compatible with tuberculosis.

*Major O'Donovan:* I would suggest that in addition to general light baths for this case of tuberculosis acutis local ultraviolet light therapy with a water-cooled lamp be used as well to shorten the time of treatment.

#### Idiopathic Macular Atrophy.—F. SHERRY-DOTTRIDGE, M.B.

A girl aged 11.

*History.*—For the past three years, small bright red patches have appeared on the extensor surface of the arms, shoulders and legs. There is no irritation. Some of the spots very slowly disappear, leaving colourless atrophic areas. There is no sign of scleroderma anywhere in the skin.

*On examination.*—Normal healthy child. No septic focus.

*Biopsy report:* The section shows hernia-like protrusions of the skin. The epidermis is thinned, cells are smaller than usual, basal cells flattened. Rete cones and papillae are missing and cutis thinned. Elastic fibres are present in the subepithelial layer, but almost absent in the upper and middle parts of the cutis. The few remnants are broken, thickened and partly arranged in bundles. The collagen is homogeneous, has lost its fibrous structure and colours badly. Infiltration, chiefly round the vessels and glands, consists of lymph cells, fibroblasts and plasma cells. Sebaceous glands are missing except for remnants but sweat glands can be seen.

I have to thank Dr. R. T. Brain for permission to show this case.

concerned also with bone development, but in this case with the calcification and hardening of osteoid tissue.

**Dr. Raymond Greene:** In the embryo, the primitive mouth or stomodæum is formed by the invagination of the epiblast. From its top Rathke's pouch grows upwards between the pre-sphenoidal and post-sphenoidal centres of ossification to meet, at the 4th week, another pouch descending from the IIIrd ventricle of the brain and thus to form the pituitary gland. Thus symbolically, out of the marriage of neurology and otolaryngology, endocrinology is born.

I shall not attempt to discuss the numerous occasions on which the interests of laryngology and endocrinology overlap, for instance in the nasal approach to pituitary tumours; in the important relationship between septic foci in the nasal sinuses and both thyrotoxicosis and diabetes mellitus; in the common occurrence of pituitary tissue in the pharynx; in the endocrine relationships of asthma; or in the effects of androgens on the growth of the larynx and on laryngeal papillomatosis. I propose, too, to give but passing reference to the possible endocrine relationship of otosclerosis, a subject ripe for reinvestigation. The literature produces a depressing effect. There is no settled criterion of diagnosis: there is an unfortunate prevalence of uncontrolled observation and therapeutic optimism. One author claims that otosclerosis is due to hyperparathyroidism on the grounds that he has produced similar lesions by the injection of dihydrotachysterol—which, however, is not the same as parathormone in its actions. Another is equally convinced of the opposite thesis, that he can cure it by the oral exhibition of parathyroid extract—which, of course, is inactive by mouth. There are some interesting and suggestive clues to follow, but at the moment we can only echo the words of Albert Gray (1934): There is no evidence whatever of any defect in any of the endocrine glands or their secretions in otosclerosis. Neither is there any evidence of any defect in the bone metabolism of the body. On the contrary, the subjects of otosclerosis are apart from their deafness, perfectly normal individuals with ordinary average health.

Nevertheless, while preserving one's scepticism of theory based on therapy, it is well to remember that every cell of the body is perpetually throughout life in contact with the very potent substances secreted by the endocrine glands. It is unlikely that any system of the body is exempt from their influence. In otolaryngology we see this influence displayed most clearly in effects on bone growth and on the mucous membranes.

We see the effects of the anterior pituitary most clearly in gigantism, acromegaly and pituitary dwarfism. In gigantism, the  $\alpha$  cells produce an excessive amount of the growth factor during the normal period of growth. For the most part, therefore, the correct relative proportions are maintained, though, owing to the strong chondrotrophic effect of the factor the long bones tend to be disproportionately long. In the skull the normal changes of maturation are often exaggerated. The maxilla of a child consists of little more than the alveolus and the frontal process. As age advances the antrum develops and the vertical height of the bone increases. This normal change is sometimes exaggerated in the giant, producing a typical facies. Abnormal development of the sinuses is seen also in acromegaly in which the excessive growth factor produces more obvious deformity because the bones developed in cartilage are no longer capable of growth. A patient of my own well exemplified the disproportionate growth of the mandible and of the soft parts of the face. Enlargement of the larynx gave him an extraordinarily deep voice. The uvula, soft palate, turbinates and nasal mucous membrane were grossly thickened, and his nose, roomy though it was, was always obstructed. His frontal sinuses were huge. In hypopituitary states, underdevelopment of the face and of the nasal sinuses is often seen, though here we have to remember the complicating factor of hypothyroidism which invariably accompanies a general hypopituitarism. The face may be merely infantile owing to a selective deficiency of the growth function, or it may show the broad depressed bridge characteristic of the cretin, due apparently to premature synostosis between the pre- and post-sphenoidal parts of the sphenoidal bone. Again a panhypopituitarism or a selective absence of the gonadotrophic function may both show themselves by the small larynx and high voice of the eunuch.

The effects of the anterior pituitary on the shape of the skull were the subject of Keith's classical work in 1911 and were also observed by Peltsohn (1918) and Escat (1922). They have recently been studied in detail by Mortimer and his associates. Mortimer (1937) found that complete hypophysectomy in the young rat retarded growth of the snout in all directions. The cranial height and width remained normal but the anteroposterior measurements were reduced. The middle table of the skull and the homologue of the frontal sinus were hypoplastic. Similar results occurred in dogs. The effects could be overcome in part by anterior pituitary extracts. Mortimer, Levene and Rowe (1937) extended these observations to man by correlating the X-rays of the skulls of nearly 3,000 patients with their endocrine histories. They divided cranial dystrophies of pituitary origin into four types. Type I showed cancellous overgrowth

of different species of animals made it clear that vitamin-A deficiency produced a definite and fairly clear-cut syndrome.

The clue to the problem was revealed when serial sections of the labyrinth were made. Mr. Hallpike gave me valuable help and guidance in this part of the investigation. The most striking abnormality in the sections of the labyrinthine capsule of vitamin-A-deficient puppies was the overgrowth of the periosteal bone. This overgrowth caused the cochlea to be more deeply placed in the labyrinthine capsule, so that the internal auditory meatus and the nerve were lengthened. In more advanced cases the bone overgrowth was seen to be in both the modiolus and the internal auditory meatus, invading and partially filling the latter, so that in these experiments the nerve was lengthened, compressed, and its course made tortuous by the overgrown bone. It was evident that the pressure of the bone on the nerve was largely responsible for the nerve's degeneration. The cochlear division was most affected, and in some cases the whole of the nerve, including all the cells of the spiral ganglion, had degenerated. The vestibular division, although severely affected, was more resistant than the cochlear division, and cells of Scarpa's ganglion were often 'squeezed and elongated by overgrown bone and yet apparently functioning. These appearances were in keeping with the known delicacy of the cochlear nerve fibres, which completely degenerate when any part of their course is injured. On the other hand, the vestibular fibres obey the Wallerian law and degenerate only on the peripheral side of the injured point.

There was serous labyrinthitis in the internal ear of these vitamin-A-deficient puppies. This appeared later than the degeneration of the cochlear nerve and was probably unconnected with it. It may have been due to changes in the cerebrospinal fluid resulting from bone overgrowth and pressure effects in the posterior fossa. The development of serous labyrinthitis in these animals may be of importance, because it probably determines whether the organ of Corti degenerates. Destruction of the cochlear nerve alone does not produce this effect, but a vitamin-A-deficient animal in which serous labyrinthitis developed showed large degenerative changes in the organ of Corti. There is some evidence, but it is not conclusive, that adding vitamin A to the diet soon after these pathological changes have developed will cure the serous labyrinthitis and prevent degeneration of the organ of Corti, but it will not, of course, restore function to the degenerated cochlear nerve.

The excessive periosteal bone formed in the labyrinth of these animals tends to be cancellous in type and rich in fatty marrow. It was thought possible at one stage of this work that a low calcium intake in the diet might play a part in this bony overgrowth. In experiments made to test this point it was found that, although additional calcium made the new bone of a more compact type, it did not prevent bone overgrowth in A-deficient animals, nor did it prevent the degeneration of the VIIIth nerve by pressure from this bone overgrowth. The olfactory nerve is also involved under these experimental conditions, but not so seriously as the auditory nerve. Vitamin-A-deficient puppies develop a great thickening of the cribriform plate and the branches of the nerve are squeezed and twisted and some of the fibres are destroyed as they pass through this bone from the olfactory mucous membrane to the olfactory lobe of the brain. The loss of the sense of smell in these animals is reflected in their behaviour, for often they appear to try to make up for its diminution by excessive sniffing. These changes are readily produced in young, growing animals (puppies rabbits and rats, but similar, although smaller, changes are found in adult animals when the experimental period of feeding is increased. Thus, whereas the pathological condition can be produced in three to five months in puppies starting on A-deficient diets at the age of about 2 months, it may take 2 years or more to produce inco-ordination in an adult dog. As would be expected, the more actively growing bone of the young animal is more rapidly affected.

There is evidence that the bone hyperplasia which so seriously affects the auditory nerve and other nervous tissue in vitamin-A deficiency is due to a derangement of osteoblastic and osteoclastic activity. Vitamin A seems to control and co-ordinate the actions of these bone cells and in its absence they do not function properly, so that bones of abnormal shape and texture are produced. Bone is laid down in places where it does not normally develop, for instance in the internal auditory meatus, and in these areas the nerves are damaged by the direct pressure of overgrown bone. In some cases, especially in certain parts of the skull and vertebral column, the normal absorption of bone appears to be suspended or delayed, and here the cranial and spinal cavities remain too small to accommodate the growing brain and spinal cord, so resulting in further gross nervous lesions. This irregularity of bone growth may, therefore, have disastrous results on the nervous system, particularly, as has been seen, on the auditory apparatus.

Whereas vitamin A has this controlling action on the shape of many growing bones, it is of interest to note that its closely associated fat-soluble vitamin—vitamin D—is

beneficent effect of œstrogens in atrophic rhinitis is greater with increasing dosage we must look elsewhere for the explanation of the effect. That the changes may be accounted for by the selective concentration of free œstrin in the nose is suggested by the animal experiments of Fisher, Krohn and Zuckerman (1936). The effect of œstrogen is a moderate vasodilatation, as Reynolds and Foster showed (1940). Eagle, Baker and Hamblen (1939) did biopsies before and after treatment. In every case there was a subjective improvement with reduction in the crusts and hyperæmia, but there was no microscopic improvement. Œstrogens have been shown by Hechter, Lev and Soskin (1940) to possess a double action, the specific one which has given them their name and a non-specific power of producing hyperæmia in many tissues. Reynolds (1939) had already shown that the hyperæmic activity of œstrogens is due to the liberation of acetylcholine. With Foster (1940) he showed that there is a local increase in acetylcholine in nasal mucosa treated in this way. Bernheimer and Soskin (1940) have completed the picture by showing that by spraying the nose with prostigmin results may be obtained which are identical in kind with, but according to them more beneficial than, those obtained with œstrogens. In every case, however, the trouble returned when treatment was stopped. The position in atrophic rhinitis may be summed up thus: we are ignorant of the causes of atrophic rhinitis, which may, however, be related to abnormal action on skull growth of the anterior pituitary. The changes in the nasal mucosa are temporarily alleviated by hyperæmia, which can be induced by œstrogens given either locally or generally. Hyperæmia is probably induced by reason of a sexual skin-like power of the nasal mucosa to concentrate œstrin, which there induces an increase in the production of acetylcholine. The process may be simplified by the direct topical application of prostigmin. Whichever method is adopted, the degree of improvement depends largely on the previous treatment of gross sepsis. The treatment, though frequently effective, is palliative, not curative. The underlying microscopical abnormality remains.

In endocrinology the terms physiology and pathology are almost synonymous, for endocrine disorder is almost always an excess or a deficiency of normal function rather than a disease process imposed from without.

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Mr. R. G. Macbeth gave an account of a short series of cases investigated in February to May 1943, in order to obtain the vitamin C levels in the blood plasma and leucocytes. The cases fell into two groups: (a) those suffering from repeated upper respiratory infections; and (b) those upon whom operations had been performed in an E.M.S. hospital. Major J. Angell James, R.A.M.C. had been associated with him in the investigation and had made the bulk of the clinical observations. Messrs. J. R. P. O'Brien and G. A. Higgins had carried out the laboratory tests.

The patients were drawn from the Services and from civilian sources, the operation cases being all Service cases. The civilian cases showing the lowest plasma ascorbic acid were largely those engaged in factory work, who took their main daily meal in the works' canteen. The following tables give plasma levels on an average as found in the laboratory of the Radcliffe Infirmary.

TABLE I.—VITAMIN C LEVELS IN PLASMA AND WHITE CORPUSCLES.

Plasma (normal, peacetime) ...	0.5-1.0 mg. 100 c.c.	White corpuscles (normal, peacetime)	20-30 mg./100g.
Plasma (normal, wartime) ...	0.3-0.6 "	White corpuscles (normal, wartime)	10-18 "
Plasma (Services) ...	0-0.24 "	White corpuscles (Services, 10 cases)	2-7 "

TABLE II.—AVERAGE PLASMA VITAMIN C FOR ALL HOSPITAL PATIENTS INVESTIGATED, MG.‰.

1940	1941	1942	1943	
0.7	0.62	0.37	0.2	(Service points)
Jan.-Apr.	May-Aug.	Jan.-Apr.	May-Aug.	
0-2	0-34	0-22	0-2	0-1
	Sept.-Dec.			
	0-34			



producing hyperplastic diploe, large sinuses and prognathism. The head is large and the face well developed. An extreme example of Type I is acromegaly. Type II is similar, but there is in addition an abnormal sclerosis of bone which the authors correlated with a period of hypopituitarism following one of hyperpituitarism. Type III shows a failure in cancellous and general growth, a small brain case and poor development of the face and sinuses. In its extreme form Type III is the face of the pituitary dwarf. In Type IV there is also hypoplasia, but in addition there is excessive sclerosis and there may be large exostoses on the inner table of the frontal bone. This is the type of skull we see most clearly in the Stewart-Morel syndrome. Mortimer, Wright and Collip (1937) found evidence of such cranial dysplasias in over 90% of their cases of atrophic rhinitis, and they were impressed by the unusually high incidence of "constitutional deafness" in their series. This term appears to include a mixed bag of juvenile nerve deafness and otosclerosis. An association of atrophic rhinitis and deafness is not clinically obvious, but in the light of the fact that a high proportion of their cases of atrophic rhinitis (and therefore perhaps of their cases of nerve deafness) are associated with calvarial sclerosis, it is clearly important to find out whether calvarial sclerosis is commonly associated with juvenile nerve deafness in general, and this Ormerod and I are now attempting. We have been impressed by the frequency with which nerve deafness in young people is associated with other changes, sometimes abnormal skull shapes, sometimes (as in the recent case of murder committed by a deaf boy during a hypoglycæmic attack) with definitely endocrine changes. Sir Edward Mellanby has just described the nerve deafness of young animals which results from the bony overgrowth of vitamin-A deficiency. Though there is no evidence of human nerve deafness due to hypovitaminosis A, I do not think that we know enough of juvenile hypopituitary states to dismiss the possibility that nerve deafness may sometimes be caused by bony overgrowth of endocrine origin. The influence of hypovitaminosis on the pituitary even makes it possible that Mellanby and I are discussing identical changes.

The relationship between the mucous membrane of the nose and the mechanism of sex is said to have been known to Hippocrates. The subject was reviewed in 1884 by Mackenzie who observed that the nasal mucosa of women becomes congested at the menstrual periods and at suppressed menstrual periods, hence so-called vicarious menstruation. In fact this congestion tends to be immediately premenstrual in time and to be relieved by the flow. Some women, as Hoeson (1938) has pointed out, tend to suffer from rhinorrhœa and asthma at this time, not because these diseases are themselves necessarily of endocrine origin but because the nose is then peculiarly sensitive. Many women suffer from an annoying nasal congestion during pregnancy and I have observed that such women are often those who suffer from menstrual œdema. Mortimer, Wright and Collip (1936, 1937, 1939) showed that in monkeys there is an increase in colour of the nasal mucosa at monthly intervals coincident with the swelling of the sexual skin. The nasal changes were 8% more regular as a sign of sexual activity than menstrual bleeding itself. They were most obvious in the fertile months of September and October. Immature and adult monkeys of both sexes, whether intact or castrated, reacted to œstrogenic treatment by reddening of the nasal mucous membrane, which occurs even if the nasal tissue is transplanted elsewhere (Bachman, Collip and Selye, 1936). The papers from the Montreal school were followed by many clinical reports of good results in the treatment of atrophic rhinitis by injections, local application and implantation of œstrogenic substances, and there is little doubt that these reports are founded on fact. The results of treatment are not, however, uniformly good, and, as Safer (1942) has pointed out, the treatment must be regarded as palliative, not curative. All patients relapse after a time if treatment is stopped. It has been pointed out also that many patients are greatly improved by the nasal hygiene which usually precedes the œstrogenic treatment; nevertheless there seems little doubt that improvement may occur without preliminary hygiene provided that gross sources of infection are absent.

The changes of atrophic rhinitis are atrophy and degeneration. The subepithelial tissues contain excess of fibrous tissue. The mucous glands are atrophied. The epithelial basement membrane breaks up and disappears and the epithelium changes from ciliated columnar to stratified squamous. There is a scantier secretion of unduly watery mucus and a discontinuity of the mucous sheet. Owing to the absence of cilia, the sheet ceases to move into the nasopharynx and the mucus dries and forms crusts. It is conceivable that improvement might be brought about by increasing ciliary movement, if the cilia have not been completely destroyed by the disease process, or by increasing blood supply. As Boyd, Clark and Perry (1941) showed, improvement in ciliary action is in fact brought about by œstrogens (œstrone, œstriol and œstradiol being effective in ascending order), provided that the doses used are minute. In larger doses, however, depression of ciliary movement occurs. As there seems little doubt that the

## Section of Ophthalmology

President—F. A. JULER, F.R.C.S.

[June 11, 1943]

### **Band Keratitis.**—O. GAYER MORGAN, M.Ch.

A case of idiopathic band keratitis in an otherwise perfectly healthy pair of eyes. The patient was a man, aged 76, who gave a history of a gradually increasing corneal opacity for at least six months. There was no evidence of any intra-ocular inflammation or degeneration. In the right eye vision was less than 6/60 and the band came right across the pupillary area. In the left there was a small notch-like clear area just in the pupillary area through which he obtained 6/18 vision. He had not at any time been engaged in work which might have produced a chronic irritation of the eye. As the disease was in Bowman's membrane and beneath it, optical iridectomy in the worse eye would seem the most satisfactory form of treatment, especially if the visual acuity in the better eye deteriorated further.

Mr. Humphrey Neame said that when such a band was definitely calcareous he had found improvement from curetting. If there was some uncertainty as to the depth this was worth trying.

The President said that he had had two or three of these cases which had done quite well by curetting the central area. This had remained clear for a considerable time.

Major E. F. King asked whether a corneal graft had been considered.

Mr. Maurice Whiting said that it might be worth while considering the question of carrying out tarsorrhaphy in the better eye. He remembered a case of divergent squint, in which the patient had a band-shaped opacity situated in the part of the cornea exposed at the outer canthus, the other part of the cornea being quite intact. Exposure of the cornea in the palpebral aperture had an important effect in the production of band opacity, and if a tarsorrhaphy were done in this case it was possible that the opacity might be prevented from becoming more extensive.

Mr. J. H. Doggart said that he had followed up several cases of bilateral band-shaped keratitis not associated with any inflammation, and those which were scraped very soon relapsed. In the few cases which had reached the calcareous stage the improvement continued for not more than a few weeks. The only two procedures which might help in this case seemed to be (1) an optical iridectomy, and (2) a corneal graft.

Air-Commodore P. C. Livingston wondered whether these cases had any nutritional element in them. It seemed worth while giving large doses of vitamin C intravenously. In somewhat similar cases he had known such doses—500-1,000 mg.—bring about a great deal of good. Improvement was perceptible within seventy-two hours of the administration. The dose was repeated every day for five days. Administration by mouth, 250 mg., was then ordered and continued for 2 weeks. The vitamin-C concentration in the urine was not of great significance. For example, a patient might have a normal vitamin-C output and yet benefit very greatly. It was essential to give the first treatment intravenously. For some unexplained reason the substance seemed to reach the cornea in a more beneficial form by intravenous injection.

Mr. O. G. Morgan (in reply) said that he was quite certain that this condition went more deeply than the epithelium. He might try vitamin C intravenously, because it could be done fairly quickly, but he felt that iridectomy was the most satisfactory treatment in this case.

### **Bilateral Buphthalmos with Congenital Anomalies of Iris and Subluxated Lens.**—VICTOR B. PURVIS, M.B.

A. B., male, aged 23, a labourer.

This was a case of bilateral buphthalmos along with a most unusual and rare condition of the iris, there being corectopia and iris dehiscence, with subluxation of the lenses.

The patient had first attended hospital a month ago, complaining that his sight had been defective since birth but very much worse during the last six years, and for the

The role of ascorbic acid in the tissues appeared to be concerned with the production of intercellular cementing substance which was not produced in scurvy and sub-scurbic states; hence capillaries broke down, infection entered and wounds healed poorly.

*"Infection" cases.*—35 civilian patients were investigated and of these 19 had a plasma ascorbic acid level below 0.2 mg.%. Characteristically, they gave a history of never having been free from colds in the winter, had persistent sore throats, attacks of laryngitis, and very often headaches. Some had spongy and bleeding gums. They all complained of lack of energy and of feeling out of sorts. In most cases history revealed a grossly inadequate intake of fresh vegetables, or of vegetables badly cooked. Some had major infections in the nasal sinuses, or middle ears, others merely showed congested noses, red and shiny pharynges, cracked lips, and excoriated nostrils. The latter type of case cleared up rapidly after having ascorbic acid for a few days; the former group required appropriate local treatment in addition. 100 to 400 mg. daily were given for ten to fourteen days (the dosage depending upon the ascorbic acid lack) and a maintenance dose of 50 to 100 mg. daily was given for a further month.

A severe case of "trench mouth" improved when given alone 1,000 mg. of ascorbic acid daily, but required arsenical treatment to heal up the ulceration completely.

Twenty Service cases were investigated. Of those, all but one (an officer) had less than 0.1 mg.% ascorbic acid in the plasma. Their symptomatology was similar to that of the civilian cases, but rather more severe. Where it was possible to take these patients into hospital, they improved rapidly on ascorbic acid therapy.

*Operation cases.*—It had been noted that in a consecutive series of 70 tonsil operations on Service patients, there were 9 cases of post-operative hæmorrhage—i.e. 13%—and of these 2 required to be given a second anæsthetic and ligature of vessels. In the same surgeon's civilian experience, with an identical technique, there had been a post-operative hæmorrhage incidence of 2% among 279 cases.

In 37 Service patients operated upon for septal resection, there had been hæmorrhage and hæmatoma formation in 4—i.e. 11%. In his previous civilian experience with 104 cases of submucous resection there had been 2% of hæmatoma.

It was then decided that Service cases, treated by operation in an E.M.S. hospital, would provide a series which could be controlled. It was arranged to give one-half of the patients ascorbic acid pre-operatively in a dosage of 1,000 mg. daily for four days, and to withhold the treatment from the other half. The same surgeon performed all of the operations, and he was kept in ignorance of the group to which each patient belonged. The operations were all performed under general anæsthetic, given by the same anæsthetist, with a standard technique.

Measurements and observations made on the two groups are listed (Table III).

TABLE III.—TABLE TO SHOW POST-OPERATIVE BEHAVIOUR OF SERVICE PATIENTS WITH AND WITHOUT ASCORBIC PREMEDICATION.

	Tonsils		Sinuses		Septa	
	Treated (13) 0.13	Untreated (13) 0.05	Treated (4) 0.10	Untreated (4) 0.08	Treated (6) 0.09	Untreated (4) 0.09
Plasma ascorbic acid level on admission (mg.%)						
Plasma ascorbic acid level on day of operation (mg.%)	0.92	0.07	1.16	0.09	1.34	0.10
Operative blood loss (c.c.)	185	165	307	406	66	75
Post-operative blood loss (c.c.)	27	45	78	102	6	75
Duration of op. (mins.)	11.2	10.1	45.8	41.6	12	19
Duration of post-op. oozing (hrs.)	1.6	6.5	2.5	3.3	3.3	10
Secondary hæmorrhage (cases)	0	2	0	3	0	
Ecchymosis (cases)	6 slight	3 moderate 5 slight 4 severe	1 slight	4 moderate	0	2 severe
First day of comfort	4th	8th	5th	13th	(Nasal breathing) 3rd	7th
Pyrexia (cases)	2	8	0	3	0	1
Otitis media (cases)	0	1	0	3	0	0
Sloughs (cases)	11 thin 2 thick	5 v. thick 9 moderate				

The figures in the first 6 lines represent averages for the patients under review.

It was also noted how much more cheerful were the premedicated patients and how much more rapidly they recovered. The others were dejected, sleeping badly, sluggish, and poor in appetite.

[Paintings of the tonsil beds of certain cases were then shown.]

It would seem, from this limited series, that there was probably a generalized lowering of ascorbic acid in members of the Forces and in civilian workers in the winter and early spring; and that there was a relation between this and upper respiratory infections and a tendency to bleed.

keratitic precipitates which had come on during measles. All who examined the case considered it to be inflammatory and he eviscerated the eye partly to give a better cosmetic result. It turned out to be a sarcoma and the child died of extension some months later.

**Progressive Partial Thrombosis of Central Retinal Vein.**—P. D. TREVOR-ROPER, M.B.  
(on behalf of Mr. P. G. DOYNE).

Woman, aged 36, who in November 1942 noticed black spots in front of her left eye for about an hour only. In May 1943 she saw further black spots lasting for about a minute, followed by slight mistiness in that eye which gradually cleared during the next few days. On admission to Moorfields next day, the right eye was found to be normal, with vision 6/5. In the left eye the vision was 6/5 and the eye was normal except for the fundus which showed dusky and engorged veins with swollen and blurred optic disc. The rest of the retina was normal save for two minute hæmorrhages along the inferior nasal vein and one near the macula. A course of heparin injections was given—60 increasing to 100 mg. intravenously, four doses at six-hour intervals. Seven days after admission she was discharged. The left eye was then normal except for the fundus which showed the same condition of the veins as on admission, increased swelling of the disc with several small hæmorrhages around it and absorption of the small hæmorrhages along the inferior nasal vein. Since then (June 1) the hæmorrhages had increased, a few more being apparent on each attendance, and the papillœdema had become more marked. There were now about four small hæmorrhages around the macula and a dozen scattered along the retinal veins.

On investigation the Wassermann reaction was negative, the X-ray of the chest was negative, and examination showed no abnormality except rather low blood-pressure (100/80) on separate occasions, and dental sepsis. The patient stated that she left Poland the day before the outbreak of war and had spent nine months previous to this in a concentration camp. Since then her health had been poor, but she had never definitely been ill. She received dental attention every few months. She had also received orthopædic treatment for a swollen right foot.

The case was of special interest in view of the slowly progressive nature of the fundus, changes consequent on the central vein thrombosis; and in condemning the use of heparin, which was shown to be of no avail even when the thrombosis was in its earliest stages.

Mr. F. A. Williamson-Noble said that he thought this was a thrombosis because the slightest amount of pressure on the unaffected eye caused venous pulsation, whereas if one pressed on the affected eye, there was no venous pulsation until sufficient pressure had been exerted to elicit arterial pulsation, at which time the vein collapsed in the same quick way as the artery.

## Chorioretinitis Associated with Toxoplasma

By DERRICK VAIL, M.D., D.O.Oxon., F.A.C.S., Lieut-Colonel. U.S.A.M.C.

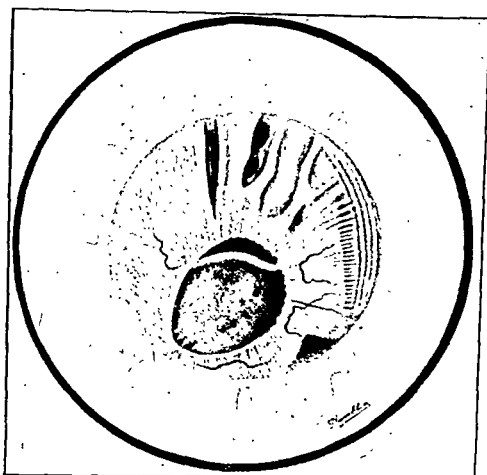
*Senior Consultant in Ophthalmology, E.T.O., U.S. Army*

CASES of disseminated and circumscribed exudative chorioretinitis are relatively common. The clinical appearance and pathologic histology of this disease are too well known to necessitate description. The ætiology of chorioretinitis, however, presents many problems and in far too many cases the cause perforce remains obscure. It is for this reason that evidence which indicates that a parasite which is probably not rare produces choroiditis in some cases assumes importance and warrants discussion, even if the evidence may not be quite complete.

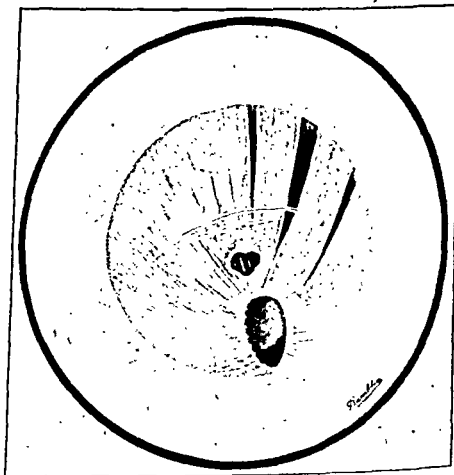
This discussion is based on two papers on the relationship between chorioretinitis and toxoplasma which have recently appeared in the American ophthalmic literature. These are by Koch, Wolf, Cowen and Paige (January 1943) and Vail, Strong and Stephenson (February 1943). The first deals with the occurrence of the disease in infants, the latter in older children and adults. A complete bibliography and review of the literature will be found in these articles. Toxoplasma, a genus of protozoan parasites, was first observed in the *gondi*, a North African rodent, by Nicolle and Manceaux in 1908 and in the rabbit by Splendore in the same year. They are highly organized parasites consisting of distinct cytoplasm and nuclear chromatin. They are crescentic, pyriform, oval, or round and measure 6 to 7 microns in length and 2 to 4 microns in width.

last few weeks he had been seeing rainbows. He was found to have enlarged corneæ and moderate myopia—wearing about  $-8$  D. sph. lenses. Vision in the right eye was reduced to hand movements, and in the left with glasses to 5/60; yet the patient was still cycling to work as a labourer. The tension in each eye was raised to 50 mm.Hg (Schiotz), but the corneæ were clear, there being only one or two ruptures of Descemet's membrane in each eye. The discs were grossly cupped and pale and the visual field in the right eye was impossible to chart because of loss of fixation, that in the left eye being reduced to within  $5^\circ$  of fixation with a 10 mm. object at 330 mm.

The main points of interest in this case were the ectopic pupils, which were displaced in an unusual direction down and out, and the splits in the mesoderm of the iris. Only one of these splits (in the right eye) was complete, in that there was an accompanying



R.



L.

Bilateral buphthalmos with congenital anomalies of iris and subluxated lens.

tear of the ectodermal layer of the iris through which a red reflex was obtainable. The condition was not one of true polycoria in which the accessory pupils each had their own individual sphincters (*see figure*).

The case is not responding to eserine therapy and the speaker proposed to carry out the drainage operation of iridencleisis in each eye.

#### Detached Retina, ? Cause.—Mrs. V. M. ATTENBOROUGH, D.O.M.S.

Boy, aged 4, first seen in February 1943. Two days before attendance he had complained that he could not see with his right eye. Four months previously he had had whooping-cough. The mother stated that he had had a fall some time before. On examination a right retinal detachment was seen with what appeared to be a disinsertion from 3 to 6 o'clock. There appeared also to be a cystic mass in the vitreous with vessels growing in at 9 o'clock. The eye was quiet. There were no keratic precipitates, no synechiæ, and no obstruction to transillumination.

Mr. R. Affleck Greeves suggested that this was a case of Coats's disease. In various places behind the retina one could see areas composed of a dense, yellowish white substance, the appearance of which suggested to him massive exudates. The vitreous was clear and this in his opinion excluded the diagnosis of an inflammatory condition. Detachment of the retina such as was present here was common in the later stages of Coats's disease. He would not advise excision.

Mr. Humphrey Neame suggested an alternative diagnosis, namely, a rather unusual endophthalmitis, with the retina very much detached. In one such case in which the eye was excised the retina in the posterior part of the eye was pulled forward very much by the tissue strands in the vitreous.

Mr. O. G. Morgan said that as the chance of retention of this eye in the future was very doubtful, and as the pathology was uncertain, he felt that it was safer to remove it. He had had a somewhat similar case with a mass in the vitreous, hypopyon and

meningeal sheath of the optic nerve showed a similar mild infiltration. Parasites were found in the tissue and within the cytoplasm of cells.

This case as well as five additional ones are described in detail by Koch and his co-workers. The eyes of four of these cases were examined histologically and all showed more or less the same picture, depending on the stage of development.

The inflammation was less pronounced in the one instance in which the lesions were somewhat more chronic. The outgrowth of granulation tissue into the vitreous was extensive, thus accounting for the proliferative retinitis that is seen clinically in some of the cases.

Wolf, Cowan and Paige (1941) presented evidence for the foetal inception of infantile toxoplasmosis. "The reasons were the onset of symptoms at or soon after birth and pathologic evidence that the lesions were present before birth. The occurrence of microphthalmos and of other congenital defects in association with the toxoplasmic chorioretinitis tends to support this view. It seems likely that the presence of the infection of the eye during intra-uterine life interferes with its normal development." It is reasonable to suppose that the parasite reaches the brain and other organs by way of the foetal circulation of the placenta.

The ophthalmologic findings in both the infantile and adult cases are the familiar ones of circumscribed exudative choroiditis. There is a predilection for the macular area and the lesions are usually bilateral and multiple. Activity of the lesion is characterized by choroidal hæmorrhage usually in the direction of the spread of the lesion. Healing is shown by pigmentation, sometimes accompanied by proliferative retinitis and in one case retinal detachment.

In eleven of the cases described the condition was probably congenital, in the twelfth it was without doubt acquired. Three additional cases occurring in adults past the third decade under my observation have not yet been reported. These are probably acquired cases of toxoplasma.

Iridocyclitis with corneal precipitates has been found twice, vitreous opacities may or may not be present.

The diagnosis in congenital cases can be made by the clinical tetrad of symptoms as described by Sabin. This is: (1) Hydrocephalus or microcephalus; (2) cerebral calcification; (3) chorioretinitis; and (4) disturbances of nervous function.

Koch and his associates believe that the intra-ocular lesions of toxoplasmic encephalitis have certain characteristics that seem to distinguish them from other forms of choroiditis. Among these are, regularity of bilateral involvement of the macular region, tendency to bilateral occurrence of other than ocular lesions, presence of massive chorioretinal degeneration, extensive connective tissue proliferation and heavy pigmentation, tendency to the occurrence of associated congenital defects in the eyes and constant clarity of the media in the presence of severe chorioretinitis.

However, in my opinion, there is nothing in the ophthalmoscopic appearance of the lesions that is characteristic, at least in the older children and adults under my observation, provided one accepts the validity of the laboratory test as the diagnostic yard-stick.

More studies are needed to prove the validity of the toxoplasma neutralization test. Up to the present the test seems most promising and accurate. Sabin's studies unfortunately have been interrupted by the war, but in a recent article he has described 151 individuals suspected of toxoplasma infection, 59 of whom gave positive neutralization tests for toxoplasma. It is significant that in 9 out of 10 cases in which the sera contained neutralizing bodies for toxoplasma, the only clinical manifestation was that of a chorioretinitis of unknown ætiology with a predilection for the macular region. Sabin had also found that occasionally the serum of the mother and less frequently the serum of the father or older siblings was also positive.

The spinal fluid or heparinized blood or both are injected into mice and guinea-pigs by the intracerebral and abdominal routes. Using rabbits, neutralization tests can also be made with human sera. For details of these tests, reference should be made to Sabin's article.

#### CONCLUSION

Cases of chorioretinitis in infants in which the toxoplasma parasite has been found microscopically have been described. Other cases in older children and adults whose

depending on the stage of development. They multiply and produce disease in a large number of hosts such as gondi, rabbit, guinea-pig, mouse, rat, squirrel, dog, monkey, pigeon and other birds, including the common fowl.

The mode of transmission to man is unknown. The parasite can multiply only in living cells and Sabin has demonstrated that they can be transferred experimentally to other animals by intracutaneous, subcutaneous, intravenous, intracerebral, intranasal and oral routes. Contact infection can occur if the animal is fed on other animals recently dead of the experimental disease.

In 1923 Janku reported the presence of parasitic cysts in the retinal lesion of the right eye of an infant who had microphthalmos of the left eye and increasing hydrocephalus from birth. He referred to them as sporozoa. Levaditi and associates in 1928 produced experimental ocular toxoplasmosis and reviewed Janku's case. They suggested that this could be one of toxoplasmic origin. This opinion is concurred in by Koch and his associates. Since it is the first case on record it seems worthy of review here. Janku's patient (as cited by Koch *et al.*), was a boy born after normal pregnancy and labour. Blindness was noted at the age of 3 months. There was progressive hydrocephalus, with death at about 16 months.

The left eye was smaller than the right, and the extra-ocular movements were limited to upward gaze and could only be performed slowly. Ophthalmoscopically, there was a large oval horizontally elongated lesion in the macular region of the right eye. It was 3 by 2 disc diameters in size and was distinctly margined by a band of dark finely granular pigment. It was atrophic and slightly concave. There was a yellowish zone just internal to the pigmented border and merging into the white of the atrophy proper. Some reddish choroidal vessels were seen in the yellow zone. There was black pigment interspersed with greyish-white tissue running horizontally and nasally in the pupillary portions of the lesion. The retinal vessels were absent in this region. The nerve head was vertically oval, blurred, greyish white and slightly elevated, and its vessels were small in calibre.

There were greyish-blue light reflexes that extended from the extreme nasal periphery of the retina of the left eye to its macular region, where there was a white atrophic area about  $2\frac{1}{2}$  by 5 disc diameters in size. This was outlined in black pigment deposition. The retinal surface nasally simulated that observed in advanced retinal detachment or in intra-ocular tumour. The atrophic zone in the macular region was depressed centrally and was yellowish white, with reddish streaks near the margins and specks of pigment increasing in number toward the periphery. No retinal vessels were visible in the central area of chorioretinal atrophy. The optic papilla was elevated and greyish, and the temporal margin was not discernible.

Histologic examination showed in addition to parasitic cysts in the retinal lesion of the right eye, a chronic inflammation of the choroid with infiltration of small round cells in the choriocapillaris. There were many obliterated vessels. There was dislocation of the nuclei of the external and internal nuclear layer. The lamina vitrea had been destroyed. There was an extensive proliferation of the pigment epithelium, but none in the central macular defect. There was an increase in the number of cells in the neuro-epithelium with many degenerating and cystic changes. In the temporal half of the retina of the left eye was a tumourlike lesion reaching from the macula to the ciliary body. There was much glial proliferation arising from the external nuclear layer. Many rosettes were present. The macula had been destroyed and replaced by glial tissue. The retina had been infiltrated by many round cells. In the choroid there were extremely large cells measuring 10 to 15 microns containing foamy protoplasm which Janku thought were coccidium.

Wolf, Cowan and Paige in 1939 found well-formed toxoplasma parasites in the granulomatous lesions in an infant who had died of congenital encephalitis when 31 days old. A Horner's syndrome of the left side, with deviation of the eyes to the right, and intermittent nystagmus to the right was mentioned in their report. The fundi revealed an irregular reddish-brown area in each macular region, about one disc diameter in size in the right eye and somewhat smaller in the left. These were thought to be the result of hæmorrhage. Histologic examination of the retina showed œdema of all its layers and distortion of the nerve fibre, ganglionic and inner molecular layers. The capillaries of this zone had undergone endothelial hyperplasia. Many nerve cells in the ganglionic layers were partially degenerated. The layer of rods and cones was markedly necrotic. The pigmented layer was partially disorganized, and the destruction of its cells gave rise to much extracellular pigment. The choroid was congested, showed capillary hyperplasia, and was infiltrated by plasma cells, lymphocytes and eosinophils. The lepto-

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## Section of Dermatology

President—H. C. SEMON, M.D.

[June 24, 1943]

SPECIAL MEETING WITH MEDICAL OFFICERS OF ROYAL ORDNANCE FACTORIES

### Prevention of Industrial Dermatitis

By SIBYL HORNER, M.D.

THE principles of prevention are: Selection, Protection (and this is wide enough to include the worker and his environment), Inspection and Cleanliness. Much might be said of the selection of the right personnel for dermatitis hazards, and present labour conditions should not deter a closer study for further information on this most important matter. I am not thinking in narrow terms of patch testing, but of the wider possibilities of analysis of the fundamental meaning of idiosyncrasy and susceptibility, which are now most imperfectly understood.

With a view to the study of such problems connected with the dermatoses of industry, Mr. Bevin, the Minister of Labour, has recently appointed an Advisory Panel on Dermatitis in Industry, which includes dermatologists and other scientists, as well as representatives from the Government Departments most concerned with this subject.

The part played by diet and vitamins in the prevention and cure of industrial dermatitis has yet to be determined, and on this and general health questions in industry we have the help of the Industrial Health Advisory Committee, set up by Mr. Bevin, with representatives from almost every branch of science. You will see in these arrangements the beginnings of a concerted scientific attack on industrial disease and disability.

### Effects on the Skin of Irritant Explosives

By CATHERINE SWANSTON, M.R.C.S., L.R.C.P.

INDUSTRIAL or contact dermatitis is responsible for more lost time in our munitions factories than any other industrial complaint—and comes only slightly below lost time due to accidents. Looked at comprehensively it is therefore a major consideration, though the individual explosives vary greatly in their irritant powers. The following figures will give some idea of the extent of the problem:

In June 1942 3.3% of the total contact workers were reported as dermatitis cases, and of this total one-quarter were off work and receiving compensation. In May 1943 1.5% of the total contact workers were reported, and of this total one-sixth were off work.

Of the total incidence, tetryl dermatitis represents a little more than half of the cases, while fulminate of mercury represents approximately one-third. But statistics based on the figure of total workers in contact with each substance shows that fulminate gives a higher percentage incidence than C.E. The remaining dermatitis figures

sera contained neutralizing bodies for toxoplasma are mentioned in the literature. This new ætiologic concept is important enough to stimulate further study.

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## DISCUSSION

The following questions were asked Colonel Vail:

(1) Might it be assumed that the parasite is of world-wide distribution and are entomologists or parasitologists agreed about its presence here?

*Reply:* The wide distribution of the parasite can be assumed from its original discovery in North Africa, its presence in Czechoslovakia and in the United States. I regret that I am unable to answer the last part of the question.

(2) Is the organism found in the blood-stream and have ordinary anti-protozoal measures been taken?

*Reply:* So far as I know the parasite has not been found in the blood-stream. It can be assumed that this is so because of the foetal infestations that have been reported, and also from the reports of cases of a milder form of encephalitis in older children, and in adults as a generalized infection with pulmonary involvement. Everything applicable to the treatment of any protozoal infestation has been tried by Sabin in the laboratory without result. Indifferent results have been obtained with chemotherapy of the sulphonamide group; sulphathiazole and sulphadiazine seem to offer the best prospects. It is necessary in the laboratory to give small doses over a long period of time in order to secure any good results, but it may not be possible to carry out this form of treatment in the human.

[The illustration of the parasite by Koch *et al.*, taken from the *Archives of Ophthalmology*, 1943, 29, 18, was shown.]

(3) How does the parasite get into the human?

*Reply:* The mode of transmission is unknown at present. No cases so far as is known, have resulted from direct contact.

(4) What conditions were found in the parents of these cases?

*Reply:* No cases have been described in which the parents as well as the child showed this lesion. The only suggestive thing was that the mother's blood-serum gave a positive test as well as the child's.

(5) Are the lesions necessarily bilateral?

*Reply:* I do not believe so, although those reported as occurring in infants have always been bilateral. Truly unilateral cases might be diagnosed from the laboratory tests as our confidence in these becomes established. It is also possible to miss old healed lesions in the periphery of the fellow eye.

or bilateral and may or may not be accompanied by a rash. A recurrent conjunctivitis in a fulminate worker is often the first sign of hypersensitivity and calls for permanent removal from this work.

*Tetryl.*—(a) Rash starts on the face—the site *par excellence*. Bright red erythema—often marked distribution round eyes, *alae nasi*, naso-labial folds and in neck creases. Incidence is highest round about the sixteenth day of continued contact (Richardson). (b) Rapidly developing severe oedema of periorbital tissues producing occlusion of palpebral fissure and interference with sight. This is a very alarming symptom and patients need to be reassured that it is temporary and that their vision has in no way been permanently impaired. It can be relieved rapidly by lying down in a darkened room and the repeated application of cold water or saline compresses to the eyes. When it occurs it is a sign of hypersensitivity, and such workers are a bad tetryl risk and should be removed permanently to other work. (c) Back of the neck—from dust collecting on the collar and rubbing against the neck. Very often the only manifestation of the rash. (d) Forearms and antecubital spaces and round wrists. Again, probably from contaminated clothing. The rash is intensely irritating, easily secondarily infected, dries and cracks easily, and desquamates profusely. The erythematous patches become confluent and in a fair proportion of cases there is a generalized outbreak all over the body, particularly upper arms, buttocks, thighs. In women the friction induced by suspenders is often the irritating factor in a spread to the thighs. (e) There is considerable yellow staining of the hands and face.

Relapses are extremely common in tetryl dermatitis—and sunlight or a strong wind is quite sufficient to precipitate a further attack in an individual who has apparently completely recovered. Merely walking through a shop where the explosive is exposed may also be sufficient, so that it is essential that all operatives who are returned to contact work following an attack of dermatitis should be closely watched.

*T.N.T.*—(a) Rash starts usually on the hands, as an erythema between the fingers, on the skin ridges or at the periphery of the palms. Thin-walled vesicles quickly appear, the erythema dies down, and a cheiropompholyx or sago-grain appearance is produced. There is some oedema, and intense irritation. Desquamation is profuse and occasionally the whole hand is degloved—the skin stripping off in large flaps. (b) Wrists and forearms where it appears very like that due to tetryl. (c) Neck creases—but very seldom on the face. (d) Wrists and feet, where the same appearance as on the hands and fingers is produced. It is important to remember when examining the feet that an interdigital mycotic infection may also be present, and may in fact be the sensitizing agent which precipitated the dermatitis. Some T.N.T. rashes become extraordinarily chronic and subject to incomprehensible relapses, for which no exciting cause can be found. (e) There is considerable yellow staining of the skin of the hands.

### Treatment

The treatment is substantially the same as for any form of industrial dermatitis. (1) Removal from contact including contaminated clothing and the cleansing of the skin as far as possible. (2) Avoidance of all skin irritants including soap and water after the initial cleansing. (3) Allaying of irritation to avoid scratching with its attendant risk of infection and—most important—so that the patient shall be able to sleep. All rashes itch more at night. (4) In all treatment the cardinal points are: (a) It must be regular—closely supervised and not left to the patient himself to carry out. (b) All dressings should be as light as possible, particularly on the hands where prolonged bandaging will produce stiff fingers. Mitts and sleeves are useful and can be substituted for heavier dressings. (c) Individuals vary greatly in their response to accepted lines of treatment and considerable variation is necessary.

We in the Ordnance Factories would welcome co-operation from the dermatologists in dealing with the problem. I am sure there is a considerable field here for further research and that the lines of treatment which have been handed down through the years are capable of much constructive revision.

### Prophylaxis

Industrial dermatitis is largely a preventable disease, but when every precaution has been taken from careful selection of workers to ideal conditions in the shops there will still be the irreducible minimum of susceptible individuals who will develop a rash.

There is at present a tremendous amount of time lost to production not only from actual cases off work—but from those who have to be transferred to other employment.

are made up from T.N.T. (trinitrotoluene) cases which do not constitute a major problem, and white spirit cases which are decreasing rapidly. Occasional cases due to shellac and varnishes, ammonium nitrate, picric shellite, lead azide, &c., are notified, but these are sufficiently rare to make little or no impression on the total figures. Recently, owing to the inauguration of certain chrome processes in a few factories, a number of cases of chrome dermatitis and septal ulceration have been notified, but it is as yet too early to be able to say if this substance will constitute a serious menace. For all practical purposes, the irritant explosives *par excellence* are mercury fulminate, and tetryl, to which may be added T.N.T., not so much because of its high incidence, but rather on account of the severity of much of the dermatitis produced by this explosive. The present paper is limited to a discussion of these three.

### *Some Factors Governing the Development of Industrial Dermatitis in Munition Factories*

(1) *Skin types*.—Both tetryl and T.N.T. are fat soluble—and it is possible that fulminate also dissolves to some extent in sebum, therefore seborrhœic and hyperidrotic skins, apart from holding the dust in close contact will exert a solvent action and so aid absorption. The thin-skinned worker presents a less resistant barrier than the horny handed, and is therefore a greater liability, and it is claimed that red heads and blondes are more susceptible than brunettes, but personally I have never been able to prove this to my own satisfaction. Coloured workers seem peculiarly resistant to dermatitis from explosives, and it may be that the pigment in the skin acts as a barrier against the irritant substance.

(2) *Age*.—The very young and the elderly are probably more sensitive, and it has been suggested that no woman over 50 should be employed in tetryl. While it is impossible to lay down a hard and fast rule, I think this is a reasonable age limit.

(3) *Sex*.—The figures available do not point to any sex distinction in the incidence of dermatitis in war factories.

(4) *Season*.—Undoubtedly warm weather which promotes sweating increases the incidence, similarly night shift with its attendant problems of ventilation under blackout conditions will give rise to many a rash in slightly susceptible workers.

*Site of lesion*.—The irritant may be solid, dust or liquid, but in the vast majority of processes necessitating the use of tetryl fulminate or T.N.T. the hazard is dust, and initial lesions occur as one would expect, primarily on the exposed skin and secondarily on areas where dust will collect. Therefore we get dermatitis arising on the face, hands and forearms, which are subjected to direct and continuous exposure, and also round the wrists, back of neck, ankles, and feet, where dust collects or is held by the clothing. Dermatitis of the face is often produced by unconscious rubbing with contaminated fingers, and an error of refraction may be brought to light only after repeated friction has produced a rash round the eyes. Common to all contact dermatitis are the widespread manifestations which occur if contact is prolonged or the individual becomes sensitized.

*Type of lesion*.—It has been said that contact dermatitis is a balance between chemical trauma and allergic reaction (Peters). The initial lesion is an erythema, but it may be follicular. Provided the patient is removed from contact and infection is prevented—this erythema will resolve, there will be some desquamation and the skin will heal. If, however, the rash becomes secondarily infected—fissures, crops of boils and pustular lesions may develop, and the condition becomes a chronic eczema which often takes months, in some cases years, to clear up. The two most important factors in preventing infection are: (a) Attention to personal cleanliness; (b) prevention of scratching by allaying the irritation.

*Fulminate of mercury*.—Except in drying and filling processes, this explosive is handled in minute quantities and contact is very slight; nevertheless, as we have seen, there is a considerable incidence of dermatitis among operatives, greatest on or about the fourth to sixth day of continued contact (Richardson).

Rash starts: (a) Back of the hands or forearms as a red, blotchy, papulo-erythema. The lesions are often discrete, circinate or nummular and except in severe cases do not coalesce in the later stages. (b) On the face—particularly round the eyes. Here there is an erythema, some œdema of the periorbital tissue, and in those with moist skins. the rash appears round the nose, mouth and under the chin, though this distribution is not so marked as in dermatitis due to tetryl. (c) Sometimes the only manifestation may be round the inner canthus—due always to friction from rubbing with the finger—and may point to the need for a refraction test. (d) *Conjunctivitis*: This may be uni-

skin allergy. It has been shown that chemicals may be antigens, i.e. substances which stimulate antibody formation, either by acting as complete antigens or as partial antigens (haptens). In the latter case, the other component of the antigen complex may be protein or some substance which carries the partial chemical antigen in a physical form capable of stimulating antibody formation by the tissues. Chemical trauma could provide such proteins by injuring the skin and these, carrying the chemical irritant, could act as combined antigens thus causing allergic contact dermatitis. In this way both chemical trauma and allergy may come into play in the causation of contact dermatitis.

**Major W. J. O'Donovan:** During the last war, in 1917, this hall was packed when this very subject was discussed [*Proc. R. Soc. Med.*, 10], "Special discussion on the origin symptoms, pathology, treatment and prophylaxis of toxic jaundice observed in munition workers." I took a part in that discussion.

On July 9, 1915, Dr. Edgar Collis went to Whitstable to see a patient whose illness Dr. Rupert Smith had connected with the "inhalation" of trinitrotoluene; this was recorded in the Special Report Series, No. 58, of the Medical Research Council as the first authentic case of liver atrophy due to T.N.T. I remember the constant help and advice on industrial hygiene given me by Dr. J. C. Bridge when alternation of employment, canteens and milk for workers, skin varnishes, the use or not of gloves, periodic medical inspection of workers and ventilation of workshops were under critical discussion in committees and in managers' offices. That munition factories are better workshops now than then, and that medical advice was early introduced into the munition service is largely due to the tireless efforts of the Health of Munition Workers Committee and Sir George Newman, and in part also to the lesser and more technical labours of the T.N.T. Committee set up by Mr. Montagu under the chairmanship of Sir Walter Fletcher and continued as an advisory committee by Mr. Winston Churchill.

All through the war Dr. Lucy Cripps, working in Coventry, was the authority on tetryl dermatitis. Her paper on this in the *British Journal of Dermatology*, 1917, 29, 3, had to be reprinted and to-day her social work and scientific records should be in our minds.

A striking chart exposing a co-incidence of T.N.T. sickness and of accidents was published by Dr. Castellain who stressed that clean working connoted skilled working; and observations by Simeon Snell in the *British Medical Journal* of March 3, 1894 (ii) 449), on the uselessness of gloves as a protective measure, were often brought to my attention.

Dermatitis due to fulminate of mercury has been mentioned to-day. Erasmus Wilson in 1845 was seized with the importance of mercurial eczema and Morrow in his great monograph on drug eruptions—republished by the new Sydenham Society in 1893—gave several pages to careful descriptions of minor and grave dermatoses due to mercury. In the last war, in one factory only, north of London, I saw several cases of "powder holes" due to mixing fulminate of mercury by hand, but so far in this war this lesion has not been recorded.

In research into "dermatitis" definitions are a prerequisite especially of "idiosyncrasy" for which "a personal, peculiar non-uniformity" has been accepted in the High Court. After personal factors of health and inheritance, hours of exposure, protective measures and acquired hypersensitiveness have been considered, the psychiatrist must be called in, for incidents like this will occur: At Faversham in Kent explosives have been made since the days of Queen Elizabeth; gunpowder was manufactured there for the British Navy and for the Gunpowder Plot; there are long local traditions of clean and safe working. In August 1918 twenty-six of forty-nine workers in T.N.T. showed for the first time "powder holes" in the skin. Noteworthy features at this date were the free sweating and deep staining of the workers' hands when extended. The tremor and sweating were attributable to the psychosomatic effects of a recent explosion and were less marked than they had been a few days previously. The workers made no complaint of any distress from these skin lesions.

With regard to dermatoses I have one clinical aid to offer: Look always for chronic marginal blepharitis and count it as a dermatological bad bargain. Those who resemble Leah the elder daughter of Laban are apt for chronic seborrhœic dermatoses. Although the sites of seborrhœa and of psoriasis are usually distinct the sites of either may be determined by a skin injury. A man with thirty years' harmless psoriasis of his knees may be severely disabled by acute psoriasis of nails and fingers after using them in a new hazardous chemical process.

Medicolegal dermatitis is "produced", not caused, by "dust or liquids". It is open to argument if a worker with chronic seborrhœa may claim disability from the sweating evoked by unusually hot working conditions; but if acne rosacea is revoltingly exacerbated by hot work in a canteen kitchen I fear the aggrieved worker would have to proceed outside the Workmen's Compensation Act.

**Sir Ernest Graham-Little:** I feel that the attention which is being paid in Parliament especially to the importance of industrial dermatitis in producing absenteeism has not been very widely recognized in the profession. I have had some figures which would indicate that the absenteeism from illness in work-people, not voluntary absenteeism or malingering, but absenteeism because of illness, is predominantly caused by industrial dermatitis. It is therefore with considerable disappointment that I read in the latest Annual Report of the Chief Inspector of Factories a rather deprecating allusion to dermatitis. If I remember the words correctly it was that dermatitis was not nearly so important as it sounded and the dubious observation was added that all that had to be done was to avoid contact with the irritating substances—which is not a very practical

The skilled worker who develops dermatitis has to be put on another process which he has to learn from the beginning, and is therefore no better than a newcomer. Prevention is easy in theory but difficult to carry out well in practice. Close co-operation is necessary between all parties in the factory—management, workers, surgery—and the most important is the co-operation of the worker. The most elaborate schemes will fall to the ground if the operatives will not avail themselves of the facilities provided.

The main points of prophylaxis are: (1) *Selection of workers*: On the lines mentioned above. All persons with a previous or chronic skin lesion, or history of trade dermatitis should be excluded. (2) *Proper working conditions*: Good ventilation in shops, including the provision of adequate exhaust draughts, mechanization of processes wherever possible, and "good housekeeping". (3) *Protective clothing*: Must be changed frequently; gloves unless worn carefully and kept scrupulously clean do more harm than good. (4) *Good ablutions*: The most important point includes adequate time, space, good soap, soft towels, face-cloths, and constant supervision. Facilities for reapplying make-up at the end of the shift will do much to encourage proper washing. Fifteen minutes required. (5) *Barrier substances*: Main value is (a) to reduce duration of contact; (b) to encourage proper ablutions. They take the form of one or more of the following: Cream—powder—varnish. Immaterial which is used provided the following conditions are fulfilled. (1) Must be acceptable to the worker, i.e. easy to apply and remove with at least no unpleasant smell. (2) Must not be perceptibly greasy as this makes subsequent working difficult. (3) Must contain no injurious substance to the skin. (4) Must neither act as a solvent on the irritant nor combine with it to form a noxious substance or one more easily absorbed by the skin. It must constantly be reiterated that barrier substances do not and cannot take the place of proper ablutions. (5) Periodic inspection of workers for early rash and removal of susceptibles so that a salted population is built up.

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**Dr. F. A. E. Silcock**: I was interested in what Dr. Swanston said about trinitrotoluene dermatitis from the point of view that it is useful to know the composition of any local medication used or one may increase the trouble. For instance, I saw two sappers with trinitrotoluene dermatitis of their hands, due to undoing unexploded land mines with bare hands. They were taken into hospital and, unknown to me, dressed with picric acid lotion. The condition got worse and acriflavine was then used instead. This increased the dermatitis and when I saw them I stopped both these treatments and ordered a simple astringent application free from all picric acid or its derivatives. My reason was that if these men were hypersensitive to trinitrotoluene, then both picric and acriflavine, being similar to it in chemical composition, would also cause dermatitis.

Dr. Roxburgh showed pictures of ordinary conditions which might be mistaken for industrial dermatitis. In the days of peace I used to see occasional cases amongst silk hosiery examiners of what appeared like a localized patch of tinea affecting the thenar eminence of the left hand. (The stocking is examined by turning it inside out over the left hand and forearm and a good examiner will do 1,200 in a day.) The condition appears to be commoner the more pure silk is contained in the stocking fabric. The affected area of skin is clinically very like ringworm, but the operatives themselves often realize that it is due to contact with silk and microscopically no fungus is present. It soon clears up after a few days off work.

**Dr. A. D. K. Peters**: I should like to ask members of the Section and Factory Medical Officers for their views on the actual way in which contact dermatitis is caused. There seems to be a general feeling that chemical trauma on the one hand and allergy on the other play a part. Perceval's experiments may be recalled in which contact dermatitis was caused by two groups of substances. In the first group the percentage of affected persons increased with the strength of the solution until ultimately all were affected; in the second group, the number affected was not greatly increased by the use of stronger solutions. These results suggest that personal sensitivity was the more predominant factor in the second group.

In the factory, it is noticed that dermatitis may result from three to four days' contact (teryll, C.E.) but that far more people are affected between the ninth and sixteenth days (Richardson).

The type and distribution of the eruption is frequently characteristic of that occurring in sensitization states.

It is commonly said that workers may become immune. Workers in contact with certain chemicals recognize a clinical syndrome in which slight dermatitis may develop which is then gradually lost while there is still contact with the causal irritant. This process is known as "hardening off" and probably corresponds with the development of immunity. The acquired invulnerability may be lost after some weeks "off contact". These clinical observations are very much in line with the experimental evidence on

## Section of Proctology

President—E. T. C. MILLIGAN, O.B.E., M.D., F.R.C.S., F.R.A.C.S.

[June 9, 1943]

### DISCUSSION ON FUNCTIONAL DISEASES OF THE COLON AND RECTUM

Sir Arthur Hurst: In order to understand the functional disorders of the colon and rectum it is necessary to have a clear conception of their normal physiology.

#### SENSORY FUNCTIONS.

Every proctologist knows that stimuli which are painful to the skin and anal canal, such as pricking, cutting and burning, produce no sensation in the colon and rectum. The only adequate painful stimulus is tension on the muscular wall. The first sensation felt is fullness, but as the tension increases this gradually merges into pain. The lumen of the colon and rectum, like that of all other hollow organs, depends upon the tone of the muscular coat, which adapts itself to the bulk of the contents. Thus the tension on the wall of an empty segment which has contracted on itself to form a solid cord without a lumen, is the same as that on the wall of a segment full of faeces or gas. If, however, faeces, fluid or gas is suddenly introduced into a segment of bowel before it has time to relax, or if the bulk is greater than the fully relaxed bowel can hold, the wall is stretched and the increased tension on the muscle fibres produces a sensation of fullness or pain according to the degree of tension. Distension of the pelvic colon gives rise to a sensation in the middle line just above the pubes and of the transverse colon slightly higher; sensation in the less mobile caecum and ascending colon and the descending and iliac colon are more accurately localized. The sensation produced by distension in the neighbourhood of the splenic flexure is indistinguishable from that produced in the stomach, so that the patient often tries to relieve himself by belching. Whereas tension in the pelvic colon immediately above the fold of mucous membrane which marks the pelvic flexure produces a suprapubic sensation, tension immediately below it produces a characteristic perineal sensation, which life-long experience has taught us to recognize as the call to defaecation. The rectum is normally empty, so that the sudden increase in tension on its walls caused by the entry of faeces is sufficient to produce this sensation, whereas the gradual filling of the pelvic colon during the rest of the day is not perceived.

#### MOTOR FUNCTIONS

The tone of the muscular coat of the colon varies with the bulk of its contents. When the colon is empty the tone is sufficient to obliterate the lumen. The descending and iliac colon are in this condition for many hours each day.

An irritable colon may be constitutional like the irritable bronchial system of the asthmatic, or it may develop after an attack of acute colitis, especially after bacillary



suggestion because during the absence of contact the worker is not working and it is that part of the problem which I think is so important.

**Dr. Sibyl Horner**, in reply: It is one of the daily tasks of the Medical Inspectors to try to reduce the incidence of industrial dermatitis by every measure which can be devised. We have published a great deal more than we used to; there have been recent memoranda on barrier substances, and on dermatitis from synthetic resins used in glues, while official placards on dermatitis are constantly being revised. I have referred to the Advisory Panel which has been set up to consider dermatitis in industry; three members of this Section are on this panel and have given material assistance, not only at meetings but in considering the diagnosis of early radium dermatitis of the finger tips in workers who are using radioactive substances in luminising work.

Medical referees who are dermatologists have been appointed, and they may help to solve some of Major O'Donovan's conundrums, especially the old-standing one of heat and friction not coming within the definition of "dust or liquids" as causes of dermatitis.

**Dr. Swanston**, also in reply: Dr. Peters has mentioned the rise in incidence in tetryl workers between the ninth and sixteenth days, and among the workers in fulminate of mercury between the fourth and fifth days. A great deal of work has been done by Dr. Peters in her factory and I agree that where there is an influx of new workers into these explosives there is an increased incidence of dermatitis which gradually dies down. As the susceptibles are removed the incidence is reduced to a minimum.

With regard to the question of allergy and chemical trauma I should very much like to hear an explanation of the acute flare-ups which occur particularly in fulminate and tetryl dermatitis, not so much in trinitrotoluene. Why should a worker who has had an attack of, say, tetryl dermatitis and is out of contact completely, sit next to a fellow worker in the bus who works in the department and develop a rash at once?

Major O'Donovan mentioned holes in fulminate workers. I have never seen one and I do not think he would see one in our factories. With regard to the alternation of workers I think there is something to be said for it, but a great deal to be said against it because it increases the number of contacts and also the potential number of cases; thus production suffers. The production staff do not like skilled workers being switched from one job to another.

ients. He often admits that he has not passed a solid stool for years. He is in fact suffering from self-induced diarrhoea. He should therefore be instructed to take no medicine and to make an effort to open his bowels every morning after breakfast, even if he feels no inclination to do so. Greatly to his surprise he generally succeeds and at the same time loses all the symptoms he had ascribed to poisoning from "constipation", which he now discovers are really the result of purgation. If he fails, the abdomen and rectum should be re-examined; an empty colon and a full rectum indicate the presence of uncomplicated dyschezia. If the rectum is empty and hard scybala can be felt in the pelvic colon through the anterior rectal wall, pelvic colon dyschezia is present.

In severe cases the diagnosis should be confirmed and amplified by an X-ray examination, carried out after an opaque meal whilst the patient is taking no aperient. In dyschezia the passage through the colon is at the normal rate or even unusually rapid, all the barium collecting in the rectum or rectum and pelvic colon within twenty-four hours. It is important to remember that an opaque enema gives no information regarding the functional state of the colon and that such radiological diagnoses as spastic or atonic colon are never justified.

*Treatment.*—Dyschezia can be cured by restoring to activity the defæcation reflexes, which had been allowed to become inefficient by neglect and by interference with their normal performance by the habitual use of aperients. Simple explanation of the physiology of defæcation and encouragement are often all that is required. But it is often necessary to reduce the work the muscles of defæcation have to perform by giving liquid paraffin, or, still better, an unabsorbable vegetable mucilage, such as isogel, to increase the bulk and soften the fæces, together with a diet containing plenty of fruit and green vegetables. It is important to avoid preparations of paraffin and mucilages, the good effects of which are neutralized by a vegetable laxative or phenolphthalein added by the manufacturer.

When the patient is unable to evacuate his rectum although it is loaded with fæces, an enema of one fluid ounce of glycerin should be given if on two successive mornings an adequate effort has produced no action. The strength of the enema should be reduced by replacing one fluid drachm of glycerin by water every other day until only water is used. By this time the normal defæcation reflex and with it the tone and contractile power of the rectum have almost invariably returned. Alternatively a pint of plain water can be used instead of glycerin, its volume being reduced by two ounces every day until the smallest effective quantity is found. This should be given every third day if the bowels are not opened in spite of an unhurried effort after breakfast each morning. The defæcation reflex is generally restored and enemas are no longer required within a month.

#### "MUCOUS COLITIS"

A large proportion of epithelial cells lining the colon, including those of the crypts of Lieberkühn, are goblet cells, the function of which is to secrete the mucus required to bind the dry fæces into scybala or cylindrical masses easy to evacuate. A more abundant flow is called forth by mechanical and chemical irritants. The only natural mechanical irritant is hard fæces, the mucus produced lubricating their passage and protecting the mucosa from damage by friction. The mucus contains no leucocytes, but it takes up any minute particles, such as degenerated epithelial cells and bacteria, with which it comes into contact. The presence of mucus with solid fæces is therefore a normal event, and it is a gross error of judgment to regard it as evidence of the mythical malady known as "mucous colitis". An unnatural mechanical irritant is a colonic douche. The mucus, which comes away with the last of the twenty or thirty pints often administered in the institutions known in America as colon laundries, which have unfortunately become so popular in recent years in this country, is not, as the high priestess assures her victims, the accumulation of months, but is a sign that the mucous membrane has had as much as it can endure and is protecting itself from further insults by throwing out a protective barrage of mucus.

The colon protects itself from irritation by purgatives by a similar secretion of mucus. If the dose is very excessive and purgation continued for long periods, this normal protective reaction merges into a condition of catarrh, which persists even when the drugs are no longer used. A more abundant secretion of mucus occurs in response to irritation by enemas containing soap, permanganate and other antiseptics, glycerin and turpentine. In the case of turpentine the irritation produces a definite inflammatory reaction,

dysentery. Such a colon responds to worry and fatigue and to excessive smoking and consumption of too much strong tea or coffee by a genuine spasm, which is sufficient to give rise to pain owing to the anoxæmia caused by the associated obstruction of the circulation, just as in the pain of angina pectoris and angina cruris. Colon spasm may also arise reflexly from local irritation in diverticulitis and carcinoma.

The haustration of the colon seen in radiographs is the result of activity of the muscularis mucosæ, which contracts so slowly that changes in their pattern can be recognized only by comparing pictures taken at intervals of one to three minutes. These movements bring portions of the fæces into contact with the mucous membrane so that water and any remaining soluble products of digestion can be absorbed. Powerful peristaltic waves, which sweep the contents of the proximal colon into the pelvic colon to await defæcation, occur only three or four times a day, each being the result of the gastro-colic reflex which follows the entry of food into the stomach, as I discovered in 1909.

*Defæcation.*—Normal defæcation depends on a conditioned reflex. An infant is trained to open his bowels when he is put on a chamber, no mental process being concerned in the act. In the course of time an elaborate conditioned reflex develops, in which getting up, a bath, dressing, breakfast, and finally sitting down in the familiar w.c. take part. As a result of this a very strong mass peristaltic wave passes along the colon, and the fæces accumulated in the pelvic colon during the previous twenty-four hours enter the rectum, which had been empty since the last act of defæcation. The consequent distension of the rectum gives rise to the "call to defæcation". The diaphragm and abdominal wall are then voluntarily contracted, and the rise in pressure within the rectum results in reflex contraction of the rectum as a whole and simultaneous relaxation of the anal sphincter, through which the fæces are evacuated.

*Constipation.*—Thirty-three years ago I suggested that all cases of constipation could be separated into two groups, colonic constipation, in which the passage through the colon is delayed, and dyschezia (δυσ, difficult; χέω, I go to stool), in which the fæces reach the rectum at the normal time but their final evacuation is delayed owing to inefficient defæcation. Many cases of constipation formerly regarded as colonic are caused by inefficiency of the conditioned reflex, which should result every morning in the passage of the greater part of the contents of the proximal part of the colon into the pelvic colon as well as the complete evacuation of the pelvic colon into the rectum. In some cases of dyschezia the conditioned reflex is unimpaired, but for various reasons it is not followed by the final defæcation reflex, in which the rectum contracts and the anal sphincter relaxes, so that the rectum is found to be packed with fæces at whatever hour it is examined. Dyschezia often originates in neglect to respond to the call to defæcate owing to laziness, insanitary conditions of the w.c. or false modesty. The double reflex becomes progressively impaired. The rectum dilates so that an increasing quantity of fæces is required to attain the internal pressure necessary to produce the call to defæcate, and finally the sensation is lost completely. The patient, however, is still capable of emptying his rectum if he tries, but by now he has generally convinced himself that he cannot get his bowels opened unless he takes a sufficient dose of aperient to produce fluid fæces which require no effort for their evacuation.

Dyschezia may also result from weakness of the voluntary muscle of defæcation, the assumption of an unsuitable posture during defæcation, and voluntary inhibition from fear of pain in diseases of the anal canal. But whatever the primary cause, the final result is the same. The defæcation reflex is lost, and the incomplete evacuation results in the accumulation of fæces in the rectum.

*Symptoms.*—In dyschezia the retention of solid fæces in the rectum, which is normally empty except immediately before defæcation, may give rise to a number of reflex symptoms, such as headache and general malaise, which disappear directly the bowels are opened. The instantaneous relief proves that these symptoms are not caused by auto-intoxication. The pressure on the surrounding parts by the retained fæces also gives rise to perineal discomfort. Pressure on the hæmorrhoidal veins may be the exciting cause of hæmorrhoids, and the passage of large hard scybala through the anal canal may produce an anal ulcer.

*Diagnosis.*—Before a self-made diagnosis of constipation can be accepted, it is necessary to ascertain what happens to the patient under natural conditions, for he rarely consults a doctor without having first followed the advice of friends or the advertisers of patent medicines. He regards himself as constipated because he habitually takes aper-

ients. He often admits that he has not passed a solid stool for years. He is in fact suffering from self-induced diarrhœa. He should therefore be instructed to take no medicine and to make an effort to open his bowels every morning after breakfast, even if he feels no inclination to do so. Greatly to his surprise he generally succeeds and at the same time loses all the symptoms he had ascribed to poisoning from "constipation", which he now discovers are really the result of purgation. If he fails, the abdomen and rectum should be re-examined; an empty colon and a full rectum indicate the presence of uncomplicated dyschezia. If the rectum is empty and hard scybala can be felt in the pelvic colon through the anterior rectal wall, pelvic colon dyschezia is present.

In severe cases the diagnosis should be confirmed and amplified by an X-ray examination, carried out after an opaque meal whilst the patient is taking no aperient. In dyschezia the passage through the colon is at the normal rate or even unusually rapid, all the barium collecting in the rectum or rectum and pelvic colon within twenty-four hours. It is important to remember that an opaque enema gives no information regarding the functional state of the colon and that such radiological diagnoses as spastic or atonic colon are never justified.

*Treatment.*—Dyschezia can be cured by restoring to activity the defæcation reflexes, which had been allowed to become inefficient by neglect and by interference with their normal performance by the habitual use of aperients. Simple explanation of the physiology of defæcation and encouragement are often all that is required. But it is often necessary to reduce the work the muscles of defæcation have to perform by giving liquid paraffin, or, still better, an unabsorbable vegetable mucilage, such as isogel, to increase the bulk and soften the fæces, together with a diet containing plenty of fruit and green vegetables. It is important to avoid preparations of paraffin and mucilages, the good effects of which are neutralized by a vegetable laxative or phenolphthalein added by the manufacturer.

When the patient is unable to evacuate his rectum although it is loaded with fæces, an enema of one fluid ounce of glycerin should be given if on two successive mornings an adequate effort has produced no action. The strength of the enema should be reduced by replacing one fluid drachm of glycerin by water every other day until only water is used. By this time the normal defæcation reflex and with it the tone and contractile power of the rectum have almost invariably returned. Alternatively a pint of plain water can be used instead of glycerin, its volume being reduced by two ounces every day until the smallest effective quantity is found. This should be given every third day if the bowels are not opened in spite of an unhurried effort after breakfast each morning. The defæcation reflex is generally restored and enemas are no longer required within a month.

#### "MUCOUS COLITIS"

A large proportion of epithelial cells lining the colon, including those of the crypts of Lieberkühn, are goblet cells, the function of which is to secrete the mucus required to bind the dry fæces into scybala or cylindrical masses easy to evacuate. A more abundant flow is called forth by mechanical and chemical irritants. The only natural mechanical irritant is hard fæces, the mucus produced lubricating their passage and protecting the mucosa from damage by friction. The mucus contains no leucocytes, but it takes up any minute particles, such as degenerated epithelial cells and bacteria, with which it comes into contact. The presence of mucus with solid fæces is therefore a normal event, and it is a gross error of judgment to regard it as evidence of the mythical malady known as "mucous colitis". An unnatural mechanical irritant is a colonic douche. The mucus, which comes away with the last of the twenty or thirty pints often administered in the institutions known in America as colon laundries, which have unfortunately become so popular in recent years in this country, is not, as the high priestess assures her victims, the accumulation of months, but is a sign that the mucous membrane has had as much as it can endure and is protecting itself from further insults by throwing out a protective barrage of mucus.

The colon protects itself from irritation by purgatives by a similar secretion of mucus. If the dose is very excessive and purgation continued for long periods, this normal protective reaction merges into a condition of catarrh, which persists even when the drugs are no longer used. A more abundant secretion of mucus occurs in response to irritation by enemas containing soap, permanganate and other antiseptics, glycerin and turpentine. In the case of turpentine the irritation produces a definite inflammatory reaction,

the mucous membrane becoming bright red with submucous petechial hæmorrhages, and the mucus contains red corpuscles and polymorphonuclear cells. I have known ulcerative colitis follow the post-operative use of turpentine enemata, the administration of which is a therapeutic sin of the first magnitude. Soap too may ultimately cause true colitis; it is no more effective than water and its popularity with the nursing profession is a misfortune.

The purely nervous form of colon spasm may be associated with excessive secretion of mucus. This may take the form of myxorrhœa, the condition then presenting a characteristic endoscopic picture of alternate contractions and relaxations of the bowel wall with an abundant flow of liquid mucus, which contains epithelial cells and, in the rare allergic cases, eosinophil cells and Charcot-Leyden crystals, but no pus cells. If the mucus is retained for long periods owing to constipation it may form thin membranous casts. This condition, for which the term muco-membranous colic should be used in place of muco-membranous "colitis", was formerly common in women, but has become very rare since the last war.

### THE RECTUM IN TABES

Some observations I carried out with H. W. Barber in 1910 on 14 cases of tabes showed that the muscle sense of the rectum is affected as constantly as that of the legs in tabetic disorders. In 13 out of 14 cases the intrarectal tension required to produce the call to defæcate was increased—in 6 to more than double the normal. In all 14 the sensation lasted for a much longer period after the pressure was released than in normal people, the time varying between fifteen seconds to six minutes, compared with the maximum normal of five seconds. The duration was longest in those who complained of morning diarrhœa, by which was meant a constantly recurring desire to empty the bowels during a period of an hour or two, a small solid stool being passed on each occasion. In 5 of the 14 cases the call to defæcation occurred only after a latent period of a few seconds instead of instantaneously as in normal individuals. The deficient muscle sense of the rectum is often associated with a similar condition of the bladder, and the patient may lose the power of dissociating rectal and bladder activity, so that the bowels are liable to act whenever the bladder is emptied. In the later stages of tabes the rectal muscle sense is totally lost, and the rectum becomes impacted with feces without any accompanying discomfort. The use of aperients then leads to incontinence.

True rectal crises are very rare; they consist of paroxysmal attacks of painful tenesmus with the secretion of excess of clear mucus.

### PAROXYSMAL PROCTALGIA (PROCTALGIA FUGAX)

Paroxysmal proctalgia, usually known as proctalgia fugax, is quite distinct in localization and character from the pain of anal ulcer and tenesmus, being felt internally, well above the anal canal. Several doctors have examined themselves during an attack and found the anal sphincter relaxed and free from tenderness. The pain is always purely perineal and never extends to the suprapubic region, nor does it radiate in any other direction. Its seat is therefore in the rectum and neither in the pelvic colon nor in the anal canal. Beginning as an ache, it rapidly increases in severity and may finally be agonizing and cause profuse sweating, the patient becoming pale and cold and occasionally breathless. He may even lose consciousness. One of MacLennan's patients came to him on account of a broken nose caused by falling in an attack. A patient of mine, an Army medical officer, collapsed in an attack whilst on parade. In a case recorded by Carlill (1935) it appeared to represent the aura of *petit mal*. Some patients are unable to pass urine during an attack, but if they finally succeed, the pain immediately disappears.

The pain has a peculiar "gripping" character, which is always the same, though it may vary in intensity in different attacks. It is generally nocturnal, waking the patient in the early morning without having given any warning the previous evening. It may follow within a few minutes of normal coitus (Thaysen), especially its resumption after a period of abstinence, coitus interruptus (MacLennan, 1917), and masturbation (Blyth). A patient of mine, 39 years old, had his first attack immediately after his first "wet dream" when a boy of 16. It lasts from five to ten minutes, rarely as long as twenty minutes. The severest attacks are generally the shortest. After a short period of exhaustion it is followed by rapid and complete recovery. Some relief is afforded by a hot bottle over

the perineum or sacrum. A doctor patient of Ryle's obtained immediate relief by rapid inflation of the rectum with air from a Higginson's syringe and another by injection of water. It recurs at long and irregular intervals, often not more than two or three times a year, and especially during periods of overwork or anxiety (Ryle). It may be associated with excessive smoking (Beckman). A patient of mine had threadworms, the frequency of his attacks varying with the degree of the infestation. Endoscopy reveals no abnormality of any kind in the pelvic colon, rectum or anal canal. The stools are normal in every way, the bowels being unaffected by the attacks. In several recorded cases the condition was familial. The father and younger sister of one of my patients suffered from exactly similar attacks.

Attacks may be prevented by ceasing to practise coitus interruptus and masturbation if they cause attacks. Beckman's patient was cured by abstaining from tobacco and relapsed on smoking again. MacLennan recommended 3 minim chloroform vaporoles and Marshall amyl nitrite capsules, the inhalation giving immediate relief in both cases, but one patient who obtained instantaneous relief by swallowing glucose (though his blood-sugar was normal) had found that amyl nitrite was without effect. Inflation with air or a little water may give relief, as in Ryle's patients, but the attacks are often over before there is time to use such treatment. Reassurance after rectal examination and sigmoidoscopy that no growth is present is an important factor in successful treatment, especially perhaps in doctors, who seem to be peculiarly liable to paroxysmal proctalgia.

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Dr. Henry Wilson: Rumination upon bowel function, and exaggerated awareness of intestinal sensation follows when (a) acute pain has been experienced, e.g. after fissure, (b) when imbalance between the sympathetic and sacral nerves occurs as the result of acute or chronic emotional upsets. These tendencies are increased if the individual has inherited a morbidly pessimistic temperament, or if his early life has been chequered by parental alarm and scares over the bowels.

The doctor's own attitude may also be warped. We may be mechanists, believing that symptoms can only come from disorder *within* the gut, or ideologically inclined to blame false imaginings within the mind. However this be, we know that fear, frustrations, tensions reflect themselves in periodic irregularities of the bowel, which may be so severe that they enter consciousness. Or the complaint may be obsessional or delusional, and the question "How do you think these symptoms are all caused?" unmasks a monument of fantastic thought. Much more common are the disorders in the over-ambitious young, or the early retired old. In both cases, concentration on limited interests leaves their minds empty, a prey to emotional strain, expressed physically in bowel irregularity. Hence, the desirability of a common-sense assessment of the patient's attitude to life and of the employment of his time. We are justified in being priests, re-directing his interests in healthy channels. We are not justified in being priests who increase his morbid horror and ignorance about the rectum, and it is essential to reduce examinations to the minimum, to carry them out in such a way that his curiosity is satisfied once, not constantly, and that the patient recognizes that where organic disease is absent we know that emotional stress produces functional disorder, and it is *that* stress that must be corrected, not the disorder alone which is to be subdued.

Dr. Geoffrey Evans prefaced his remarks by asking Sir Arthur Hurst if he would use the term sigmoid or rectal constipation instead of dyschezia, because the latter term meant nothing to most students. Later, in reply, Sir Arthur agreed to this, provided that Dr. Evans would use the term pelvic colon instead of sigmoid! In speaking of constipation Dr. Evans limited his observations to the evacuating mechanism, and said how much he had learnt from proctologists of the importance of even minor disease and disabilities of the anal margin, anal canal and lower rectum, in preventing the normal reflex activities involved in defaecation. He advised proctologists of the necessity

of restoring normal bowel function to patients after operation, pointing out that this is an essential part of the rehabilitation in their surgical practice, and that many patients at the present time are introduced to the laxative habit as a result of surgical treatment in hospital or nursing home. Dr. Evans made a brief reference to the physiology of normal bowel function as outlined by Sir Arthur Hurst, and stated that the evacuation of a formed stool with a sense of completion is the ideal, and that perfection of function is perhaps even more important than regularity. His opinion was that it is the sensation of incomplete evacuation which often determines the laxative habit, and may on occasion cause proctalgia fugax. After brief reference to the effect of over-fatigue, bad habits, wrong food, emotional or psychological disturbance, and the trauma of childbirth, as causing constipation, he referred to constipation as being due on occasion to an inherited neuromuscular defect of the pelvic colon. He also suggested that there exists a neuro-secretory disorder, namely a dry pelvic colon, which can be recognized by sigmoidoscopy, and might be as important as a neuromuscular defect in determining constipation. He thought that some cases of ulcerative colitis might be initially due to stercoral ulceration, resulting from a dry pelvic colon and consequent continuous retention of particles of faeces in it.

Dr. Edward Larkin (*Précis*): In patients complaining of rectal trouble the following six syndromes are notoriously intractable: Chronic functional constipation; fussing about the bowels, whether the patient brings actual stools or lengthy bulletins about them to the proctologist; delusions that the perineum smells; persistent pain in the rectum or lower abdomen without organic cause; spasm of the anus or colon; intractable colitis. Patients suffering from these all have psychological disorder.

In the first three syndromes, the symptoms are expressions of a general state of anxiety which the patient is focusing on his defaecatory mechanisms by a process of thought of which he is unconscious. His general state of insecurity and fear is focused on to fear, in the first syndrome, of what the constipation is doing to him; in the second, on to fear that his bowels are going wrong; in the third, that he may become a social outcast. In the case of the chronic constive, his preoccupation with the deranged function makes the function worse. A vicious circle is established which may sometimes be broken by laxatives but more permanently and surely by attacking the neurosis as well.

The other three syndromes, rectal pain, spasm and intractable colitis, are examples of another type of anxiety reaction, somatic conversion of anxiety. Fear has physical accompaniment: one person when frightened will palpitate and even get a spasm of præcordial pain, another will become breathless, another has frequency of micturition, another has an unpleasant feeling in the pit of his stomach. There are others whose emotions fly to their bowels, and it is these people who, if they get a conversion neurosis, get a bowel neurosis. An individual's attitude to life is largely determined by the type of reaction he experiences in emotion and those whose emotions fly to their bowels have a certain type of character. A knowledge of this type of character is necessary when treating the cases under discussion.

They tend to be inhibited people, with whom it is hard to be in sympathy, meticulous precisionists, obsessional, over-attentive to detail, ritualistic (hence their love of regimes and dietaries), superstitious, sadistic and ambivalent. (The sadistic and ambivalent person is always hurting the thing he loves, impulsively saying unforgivable things and just as impulsively becoming devastatingly contrite). These various characteristics will be modified according to the patient's intelligence and upbringing and he will, unless exceptionally gifted and self-aware, be without insight in regard to them (unconscious of them). A common resultant character is that in which the person has over-compensated for his sadism and superstition with undue gentleness and religiosity. His obsessional meticulousness also give him a predilection for logic and verbal wit in which, incidentally, his sadism usually has full play so that he is frequently sarcastic and cynical. Often this religious tendency and verbal dexterity give him a natural aptitude for philosophy. On the other hand, many of the other characteristics can be admirably expressed in surgery.

In the handling of these cases, their state of emotional inhibition makes them difficult. This must be understood so that it can be allowed for. Unlike the cardiac cases, they have no common language. In literature and conversation, referring of emotion to the heart is commonplace, so that cardiacs speak the common language of the emotions and

can share their feelings readily. But our patients have, as it were, lived among strangers all their lives and have never been sure that their feelings are understood. Therefore when they do get the ear of a doctor, a lifetime of repressed feeling becomes released on the first person who is prepared to meet them on the rectal level; and even then, the meticulousness will have its way so that the patient is apt to become very tedious. Furthermore, because of the aura of shame, people do not usually discuss their bowels so that they cannot know, as a patient with a common cold knows, that their symptoms are commonplace and easily understood. The anal character is established and in-eradicable by the time a patient comes to a proctologist and it is wise to humour it by giving the patient a ritual to live by.

*Treatment.*—Psychoanalysis is impracticable in these cases. The principles of psychiatric practice, i.e. rest, reassurance and distraction, should be employed. The patient is in a state of chronic anxiety, usually with a severe secondary depression. He must be rested and distracted from his depression and his anxiety must be eased by reassurance. His symptom should not be disregarded as this would increase his feelings of insecurity by adding the doubt that he is suspected of mental infirmity. If a psychiatrist is called in, he will discover certain mental conflicts and by helping the patient to resolve these, will ease the tension and so promote rest. A psychiatrist will not always be necessary as in L. D.'s case of a prospective bride who suddenly developed hæmorrhagic colitis. He made her go on with the wedding and the symptom was cured. She no doubt had an unresolved conflict about the wedding which he resolved for her. Distraction eases tension by getting the patient's attention off his conflicts, a holiday or some new interest will serve this purpose. For example, a dowdy spinster living in an unhappy home had severe chronic colitis with pus and blood in the stools. After she had been rested and reassured, distraction was ensured by getting her hair and complexion restored by art, encouraging her to keep them so and getting her a simple but important sounding job in an aeroplane factory. She is still rather a miserable individual but her colitis has gone.

The sedative drugs are very valuable in the treatment of the anxiety and depression. Sleep should be secured, if necessary, by hypnotics. Nearly every case, whether sleeping or not, will be benefited by a thrice daily dose of bromide or barbiturate. Everything possible should be done to ease tension, that is why the complexes must not be probed fiercely nor should arguments ever be allowed; in any case the person with the anal character is, as has been pointed out, likely to be the better dialectician.

[Several cases were then quoted illustrating the various points raised in the paper.]

Mr. Michael Smyth drew attention to megacolon, a condition in which there might not be an evacuation of the bowel for weeks at a time. The pelvic colon was most frequently affected, but the condition might extend through the large intestine. He was not referring to Hirschsprung's disease in which there were gross inflammatory changes, but to a much milder condition, chiefly characterized by dilatation of the colon. X-ray with barium enema often showed a pelvic colon which accommodated 2 to 3 pints, whereas  $1\frac{1}{2}$  pints of barium ordinarily outlined the large intestine right back to the cæcum. Purgatives in such cases only increased the discomfort of the patient, and the remedy lay in sympathectomy.

It was said that the anal sphincter and the pelvirectal sphincter were causative factors and that dilatation of these sphincters would alleviate if not relieve the condition. In support of this he recalled a case where a boy was brought into hospital with prolapsed intussusception of the pelvic colon; about a foot of the bowel protruded through the anal sphincter, and it was necessary to open the abdomen to reduce the prolapse. Barium enema afterward showed great distension of the pelvic colon. The accident probably had the effect of dilating the sphincters, for previous to operation the patient had suffered from severe constipation—a bowel action once in seven to ten days—whereas afterwards he never went for longer than two days at a time without an evacuation.

Dr. W. E. Cooke said that he did not consider it safe to assume that the presence of mucus on a formed stool was always indicative of slight constipation or was always of non-pathological import. In tropical medical practice such a stool calls for investigation



of restoring normal bowel function to patients after operation, pointing out that this is an essential part of the rehabilitation in their surgical practice, and that many patients at the present time are introduced to the laxative habit as a result of surgical treatment in hospital or nursing home. Dr. Evans made a brief reference to the physiology of normal bowel function as outlined by Sir Arthur Hurst, and stated that the evacuation of a formed stool with a sense of completion is the ideal, and that perfection of function is perhaps even more important than regularity. His opinion was that it is the sensation of incomplete evacuation which often determines the laxative habit, and may on occasion cause proctalgia fugax. After brief reference to the effect of over-fatigue, bad habits, wrong food, emotional or psychological disturbance, and the trauma of childbirth, as causing constipation, he referred to constipation as being due on occasion to an inherited neuromuscular defect of the pelvic colon. He also suggested that there exists a neuro-secretory disorder, namely a dry pelvic colon, which can be recognized by sigmoidoscopy, and might be as important as a neuromuscular defect in determining constipation. He thought that some cases of ulcerative colitis might be initially due to stercoral ulceration, resulting from a dry pelvic colon and consequent continuous retention of particles of faeces in it.

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## Section of Orthopædics

President—B. H. BURNS, F.R.C.S.

[June 26, 1943]

MEETING AT PRINCESS MARY'S R.A.F. HOSPITAL

### Skin Grafting in the Treatment of Wounds

By ARCHIBALD H. McINDOE, F.R.C.S., F.A.C.S.

THE early application of skin to any raw surface is as important as the early immobilization of a fractured bone. This is true whatever the nature of the wound, and wherever it may occur. Though it is widely believed that the only variety of wound meriting a skin graft is an extensive superficial soft tissue injury with loss of skin, the most important results follow quick healing in compound injuries involving tendons, bones, and joints. It is precisely in the field of orthopædic surgery that the value of early skin replacement should be fully appreciated and more widely practised. The day has passed when healing of extensive skin losses by scar tissue should be countenanced. Treatment of this sort is a surgical crime. The inevitable results of slow healing, particularly in areas of functional importance, are contractures and deformity, deep fibrosis of muscle tissue, obliteration of tendon sheaths, periarticular fibrosis with loss of movement in joints, and decreased excursion and power in muscles. The advantage of quick epithelialization is that the progressive fibrotic organization which constantly occurs in an open wound and in the tissue lying beneath it is immediately converted into a process of resolution and absorption of inflammatory exudate with resultant tissue softening. Intact skin is the only efficient barrier to the entrance of infection.

Provided there are no deep foci of infection established in the tissues the sooner a skin covering is obtained the better. Even if it is a temporary covering to be replaced later by another type of graft for functional or cosmetic reasons, its early successful use will sometimes avoid weeks of pain and suffering and possibly a lifetime of disability and disfigurement from scar tissue contraction or chronic ulceration.

*Types of skin loss resulting from injury.*—(a) Traumatic loss of skin resulting from missiles, explosions, high speed crashes or surgical excision. (b) Burns; thermal, chemical or electrical. The differences in extent, character, and behaviour of these two types are at once obvious to any surgeon of experience.

(a) Skin loss due to trauma is usually fairly limited in extent and is often associated with muscular, bony, or visceral injury. Extensive skin loss from trauma usually means equally extensive deeper damage and death. Furthermore the skin loss is practically always full thickness, is well defined and when the wound is excised at once a clean healthy base is left. With control of infection there is an immediate tendency to rapid epithelialization, and normal healing. An exception to this general rule is the partial or total "degloving" of arm or leg following crash or run-over accidents, the clinical course of which is allied to the severe third degree burn. The more rapid improvement in the general condition of patients with traumatic losses of skin accounts for their more effective epithelial response, but also the localized nature of the loss makes treatment of the raw surface more efficient. Rest and immobilization, for instance, are more easily obtained.

(b) Third degree burns involving the entire thickness of the skin are the most common and important source of raw surfaces in war and peace. These differ from traumatic skin losses both in extent and clinical behaviour. They may involve large areas of the body surface and must always pass through an initial period of superficial sloughing before a clean base can be obtained. During this period of delay, the general condition

microscopically, and notably in a patient suffering from rectal bilharziasis (schistosomiasis) it may contain ova of *Bilharzia mansoni*; where a chronic amœbic dysentery is present *E. histolytica* may be found.

Dr. F. Parkes Weber thought that the normal reflex mechanism of defecation was much more easily disordered in some individuals than in others. He wondered that it was not even more frequently damaged, as the temptation to neglect the calls of Nature (hurry to begin the morning's work or pleasure, &c) was often very great. Those in whom the calls were usually somewhat weakly felt, were likely to grudge the delay in beginning their day's programme.

Paroxysmal proctalgia, he thought, was only one variety of pain in the viscera due to spasmodic contraction of unstriated muscle. He agreed that all possible reflex exciting causes (including prostatic) should be thought of before diagnosing paroxysmal proctalgia as idiopathic. Only a few individuals seemed to be born so constituted that in adult life they suffer from many kinds of severe abdominal pains (apparently all due to cramp-like contraction of unstriated muscle) from no obvious exciting cause or only from fatigue or emotional disturbance.

Mr. Stephen K. Westman said that there was a close resemblance between the anatomy, physiology and certain functional diseases of the colon and rectum and those of the female reproductive organs. The occurrence of spasms in both areas pointed to inco-ordination between contraction and relaxation of sphincters under the control of the presacral nerve. In cases of spastic dysmenorrhœa there were degenerative changes in Nissl's granules in this plexus which could be influenced by œstrin. The application of hormones in spastic conditions of the colon and rectum should produce equal or better results than operative interference with these nerves especially in combination with psychotherapy.

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Provided there are no deep foci of infection established in the tissues the sooner a skin covering is obtained the better. Even if it is a temporary covering to be replaced later by another type of graft for functional or cosmetic reasons, its early successful use will sometimes avoid weeks of pain and suffering and possibly a lifetime of disability and disfigurement from scar tissue contraction or chronic ulceration.

*Types of skin loss resulting from injury.*—(a) Traumatic loss of skin resulting from missiles, explosions, high speed crashes or surgical excision. (b) Burns; thermal, chemical or electrical. The differences in extent, character, and behaviour of these two types are at once obvious to any surgeon of experience.

(a) Skin loss due to trauma is usually fairly limited in extent and is often associated with muscular, bony, or visceral injury. Extensive skin loss from trauma usually means equally extensive deeper damage and death. Furthermore the skin loss is practically always full thickness, is well defined and when the wound is excised at once a clean healthy base is left. With control of infection there is an immediate tendency to rapid epithelialization, and normal healing. An exception to this general rule is the partial or total "degloving" of arm or leg following crash or run-over accidents, the clinical course of which is allied to the severe third degree burn. The more rapid improvement in the general condition of patients with traumatic losses of skin accounts for their more effective epithelial response, but also the localized nature of the loss makes treatment of the raw surface more efficient. Rest and immobilization, for instance, are more easily obtained.

(b) Third degree burns involving the entire thickness of the skin are the most common and important source of raw surfaces in war and peace. These differ from traumatic skin losses both in extent and clinical behaviour. They may involve large areas of the body surface and must always pass through an initial period of superficial sloughing before a clean base can be obtained. During this period of delay, the general condition

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Paroxysmal proctalgia, he thought, was only one variety of pain in the viscera due to spasmodic contraction of unstriated muscle. He agreed that all possible reflex exciting causes (including prostatic) should be thought of before diagnosing paroxysmal proctalgia as idiopathic. Only a few individuals seemed to be born so constituted that in adult life they suffer from many kinds of severe abdominal pains (apparently all due to cramp-like contraction of unstriated muscle) from no obvious exciting cause or only from fatigue or emotional disturbance.

Mr. Stephen K. Westman said that there was a close resemblance between the anatomy, physiology and certain functional diseases of the colon and rectum and those of the female reproductive organs. The occurrence of spasms in both areas pointed to inco-ordination between contraction and relaxation of sphincters under the control of the presacral nerve. In cases of spastic dysmenorrhœa there were degenerative changes in Nissl's granules in this plexus which could be influenced by œstrin. The application of hormones in spastic conditions of the colon and rectum should produce equal or better results than operative interference with these nerves especially in combination with psychotherapy.

## Section of Orthopædics

President—B. H. BURNS, F.R.C.S.

[June 26, 1943]

MEETING AT PRINCESS MARY'S R.A.F. HOSPITAL

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of the patient may have deteriorated owing to sepsis and toxic cachexia, or to protein and hæmoglobin leakage from the raw surface itself. Hypoproteinæmia and anæmia are potent factors in slowing up epithelial growth.

*Healing of raw surfaces.*—Speedy epithelialization of wounds due to trauma or to burns is largely determined by the situation and extent of the skin loss, the degree of involvement of deeper structures, the degree and type of local infection, and the general condition of the patient as well as the kind of treatment adopted to control the infection. Other things being equal, the rate of normal epithelial spread is a constant for various parts of the body decreasing from the head downwards. At its best it is about 0.5 mm. per day (Howes, 1943). It is least rapid in the lower leg and foot. Hence the volume of the blood supply is a dominant factor. The longer a raw surface is exposed the poorer the blood supply to the proliferating epithelium and the slower the rate of growth. This is especially noticeable at the central point of a healing surface where the granulations have been exposed for the longest period. The last few square centimetres of exposed surface are always the most difficult to epithelialize. A granulating surface showing a strong spontaneous healing tendency should be smooth, salmon pink or red, firm and flush with the general surface or slightly depressed below it, and painless to touch. Its margins should be surrounded by a bluish-white film of epithelium growing centripetally and attaching itself to the granulations in its progress. Daily observation of the rate of creeping epithelialization by direct measurement will after a few days give one an idea of how long the process may be expected to take and whether grafting is advisable. The type of superficial exudation is also of importance; ideally it should clot, forming an almost clear jelly after standing for a few minutes. Its bacterial and leucocytic content should be limited to saprophytic organisms and a few polymorphonuclear leucocytes.

Infected raw surfaces present painful, soft, nodular, exuberant greyish-yellow granulations exuding frank pus which covers the surface in a creamy layer. There is little or no epithelial response at the edges and later reduplication of the epithelium occurs which fails to adhere to the granulating base. The causes of the infection are usually obvious and in order of frequency are as follows:

(1) Superficial secondary infection introduced by surgeons, nurses, or the patient himself and usually a hæmolytic *Staphylococcus aureus*, a hæmolytic streptococcus *B. proteus* or *B. pyocyaneus*.

(2) Retained foreign bodies, sloughs and sequestra, especially in deep undrained pockets in the wound due to inefficient primary debridement and excision.

(3) The trauma of dry or alleged wet dressings frequently removed together with the growing epithelial edge and the surface of the granulations.

(4) The trauma of antiseptics more harmful to the surface than to the organisms implanted therein, e.g. silver nitrate, phenol.

It still remains true that a clean wound handled without trauma heals rapidly and a dirty one treated roughly does not, that free drainage is essential and that a "closed" method of treatment which favours underlying sepsis and sodden infected dressings does not favour rapid healing. If healing is painfully and slowly achieved in these circumstances the scar epithelium may break down again under the slightest trauma or thicken to form unstable keloid tissue.

*The diagnosis of the extent of skin loss.*—This is of the utmost importance. The bursting effect of a missile may produce a gap out of all proportion to the actual skin loss. Hence rapid healing in apparently extensive losses may be entirely due to the re-establishment of normal tissue tension when reactionary œdema has subsided. It is often claimed that epithelialization is rapid under plaster whereas the truth is that the skin edges have simply re-aligned themselves under favourable conditions of rest and immobilization, and what was at first sight a true skin loss is in fact a disruptive effect of the injury. One of the most common mistakes to be seen in hospitals to-day is persistence in the use of a plaster case in compound limb injuries in an effort to obtain epithelial healing months after its real function has been fulfilled. It cannot be too plainly stated that while a plaster case is an excellent medium for the growth of granulation tissue and the repair of bone, it is a poor milieu for skin. When the bony lesion is satisfactorily dealt with the plaster should be removed forthwith and the skin loss, then clearly determined, made good by a skin graft of the appropriate type. By careful measurement of the initial injury in comparison with the intact side an accurate estimate of the true skin loss can usually be made.

*Exposed deep structures.*—It goes without saying that every wound should be subjected to a careful toilet by excision of all damaged and non-viable tissues such as skin, muscle, fascia, tendons or bone. If, however, otherwise healthy tendons and bone

are exposed for very long, additional sloughing and sequestration will soon occur before they can be covered by granulation tissue (Kitlowski, 1941). These structures are unfavourable bases for free grafting, hence pedicled flaps applied immediately have a considerable field. Probably all explosive wounds of the hands exposing localized areas of bone, tendon or involving joints should be treated with pedicled abdominal flaps. Only by quick healing obtained in this way can function in what remains of the hands be preserved.

*The site of the skin loss.*—The relative importance of the area of skin lost is, of course, entirely dependent on the site of injury and the function of the part. Thus a square inch lost from an eyelid may produce rapid ectropion with exposure of the globe, corneal ulceration and loss of vision. The same amount lost from the dorsal or ventral surface of an interphalangeal joint may mean absorption and disruption of the extensor tendon in the former case or a severe contracture in the latter, with the production in both cases of a practically incurable flexion deformity of the finger. Other sites of functional importance where minimal skin loss is serious are the extensor and flexor surface of the hand, over the tendo Achillis and os calcis and in the neighbourhood of flexures and poorly protected joints such as the elbow. At all these places early skin replacement is imperative if functional disabilities are to be avoided. Elsewhere in areas of non-functional importance the matter is not so urgent. In general, raw surfaces in these areas larger than the palm of the hand should be grafted, particularly if they are more or less circular in shape. Long narrow defects often heal rapidly from the sides.

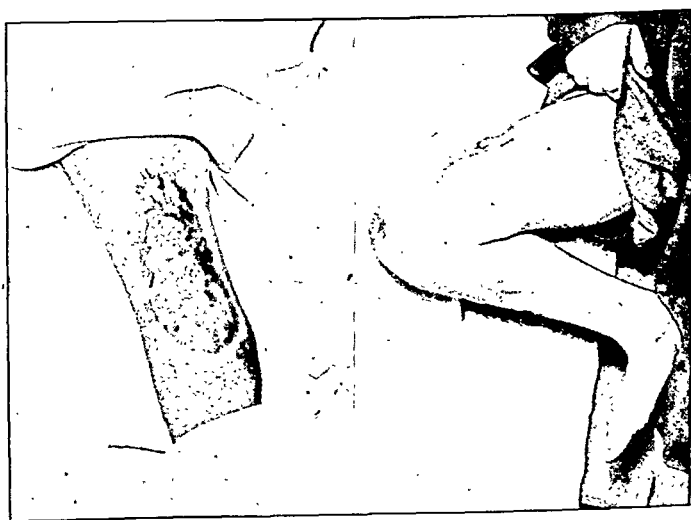
*Immediate versus delayed grafting.*—In both burns and traumatic injuries a skin graft may be applied immediately, or after excision of the wound. In most instances, however, and particularly with burns, delayed grafting is the method of choice after infection has been controlled and a satisfactory granulating surface has been produced. But wherever possible the immediate use of a skin dressing is to be preferred. Ideally the treatment of a wound with loss of skin would involve the immediate regrafting of the actual piece lost after suitably preparing it as a free graft (fig. 1) (Jays, 1942). This is sometimes possible and is always worth attempting. But under the imperfect conditions of war early treatment should consist of careful cleansing, excision of all damaged and non-viable tissue whatever its nature, bacteriostasis with sulphonamide, followed by the application of the appropriate skin cover, light pressure and immobilization of the part. Ligatures are limited to the larger blood-vessels and all tension is rigorously avoided, particularly by deep or superficial sutures. In superficial wounds of the face, trunk or limbs or those in more extensive degloving accidents of the extremities, a simply applied and perforated split skin graft is imperative. In compound fractures of the limbs the graft can be used after excision of the wound and before its encasement in plaster. Explosive wounds of the hands with localized exposure of tendons, bones and joints require some designed form of abdominal pedicled flap. Only in fairly localized third degree burns and in areas of non-functional importance is it possible to use an immediate graft because one cannot be sure of the exact depth of the burn when it is first seen. Immediate grafting is determined by the degree of wound infection and this by the time interval which has elapsed since injury. Twenty-four hours is permissible with facial wounds, correspondingly less in the trunk and extremities (McIndoe, Fry and Shepherd, 1943). With efficient first-aid treatment, however, the essence of which is protection against secondary infection, immediate grafting has been undertaken as much as four days after infliction of the wound.

Delayed grafting means the application of a skin covering to a prepared granulating surface. Speed in the preparation of such a surface is essential in order to prevent the excessive formation of that thick basic layer of fibrous tissue which is eventually so crippling from a functional standpoint. Thus a traumatic skin loss, free of sloughs from the beginning and treated by an open method should be ready for grafting in seven to ten days. Granulating surfaces developed under plaster usually require a further five to seven days sterilization though occasionally they may be dealt with immediately the plaster is removed. Practically all third degree burns treated by the saline, sulphanilamide and tulle gras method should receive their initial grafts between the third and fourth week.

*The control of infection and the conditioning of the granulating surface.*—It is generally agreed that the quickest method of preparing a granulating surface for grafting is by saline and half-strength eusol pressure dressings applied frequently and atraumatically with tulle gras applications to prevent adhesion of the gauze packs to the delicate proliferating surface (McIndoe, 1941, 1942). This is true whether plaster is used or not. Specific antiseptics may be necessary in certain instances, e.g. sulphanilamide, sulphathiazole and proflavine powder for staphylococcal and streptococcal infection



15.12.41.



16.2.42.

19.5.42.

FIG. 1 (Case of Mr. P. H. Jayes).

15.12.41, 12.30 p.m.: Large piece of skin and subcutaneous tissue removed by horse bite. Mother replaced piece of skin on raw area a few minutes later. 3 p.m.: Patient admitted to hospital. 4 p.m.: Operation. Raw area, 7 in. by 3½ in., cleansed with saline. Detached portion of skin washed in saline; subcutaneous fat removed and it was converted into a Wolfe graft. Sewn in position; whole defect covered.

Final result: Knee flexion and extension full.

or penicillin and propamidine for sulphanilamide-resistant organisms. 1% acetic acid alternating with sulphanilamide powder is useful for *B. pyocyaneus* but this organism is difficult to eradicate by any known method. The two organisms to be most feared are a hemolytic *Staphylococcus aureus* and a sulphanilamide-resistant hemolytic streptococcus. Experience shows, however, that it is unnecessary and indeed impossible to produce a surface completely free of all these organisms. What is necessary is to reduce the total bacterial flora to a point where a graft will take. Moreover of the five or six common bacteria infecting a given surface it is not sufficient to eliminate one or two leaving the remainder to flourish. Any organism capable of producing pus sufficiently rapidly to lift a graft from its bed during the first twenty-four hours will prevent its take. The practical requirement falls far short of complete sterilization. An accurate knowledge of all the bacteria present is of great value as a guide to the specific treatment to be adopted but only clinical experience founded upon the appearance of the raw surface and the character of the discharge can determine the correct time to apply skin grafts. The bacterial count, for instance, is often misleading. The most reliable guide is the condition of the healing edge and its rate of spread. If this is proceeding normally the graft will almost certainly take. Skilful and devoted nursing carried out under aseptic

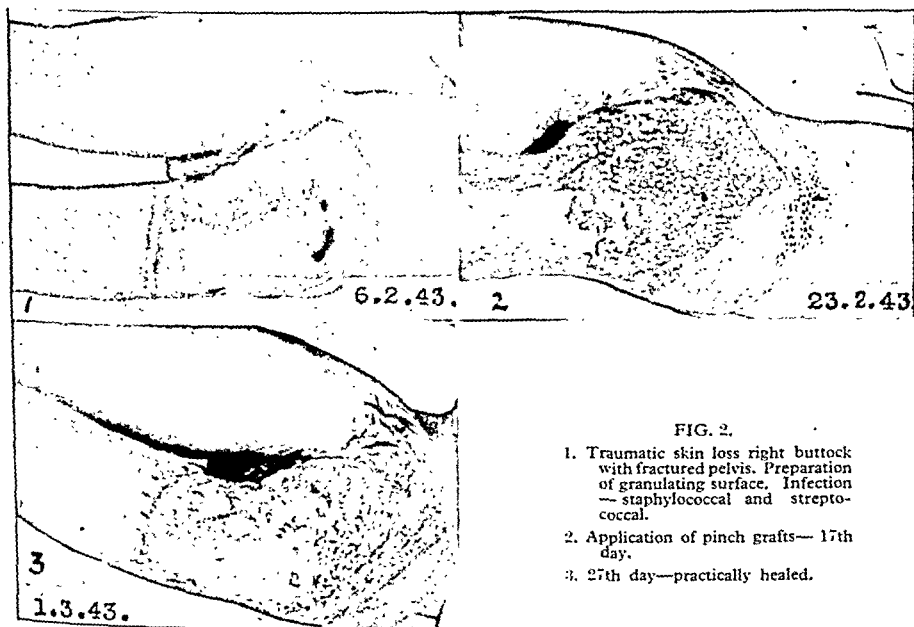


FIG. 2.

1. Traumatic skin loss right buttock with fractured pelvis. Preparation of granulating surface. Infection — staphylococcal and streptococcal.
2. Application of pinch grafts— 17th day.
3. 27th day—practically healed.

regime are more important than any magical application from a bottle. Dry heat, ultra-violet or infra-red lights, silver nitrate pencils or caustics should never be used. They are wrong in principle and do far more harm than good. The quality of a conditioned raw surface depends most of all on the quality of the Sister in charge of the ward in which the patient is treated.

*Varieties of skin grafts and indication for their use.*—The five varieties of skin grafts used in the treatment of wounds are: (1) Small deep grafts (Staige-Davis, 1930). (2) "Postage stamp" grafts (Gabarro, 1943). (3) Thin razor grafts (Ollier-Thiersch). (4) Thick razor grafts (dermo-epidermal, intermediate or split skin grafts). (5) Pedicled flaps.

(1) *Small deep grafts.*—Small cones of skin removed under a local anæsthetic from an inconspicuous site are applied directly under pressure to clean granulations. They consist of whole thickness skin at the apex, epidermis and dermis in the midperiphery and epidermis alone at the edges. They should be 2 to 3 mm. in diameter and are spaced mathematically over the raw surface not more than 1 cm. from each other. The pressure is removed in three days and the original cleansing treatment of the raw surface

reinststituted. Coalescence of the grafts should be complete in three weeks. Their field of usefulness is now very wide. They are suitable for all extensive raw surfaces on the trunk or limbs where continuous sheet grafts are difficult to obtain or where their employment would be associated with risk to the patient (fig. 2). Small deep grafts afford excellent drainage for the incompletely sterilized surface and so allow of an earlier and surer take. The immediate cosmetic result is not pleasing but the ultimate appearance is satisfactory and the cover is stable. They should not be used on the hands or face or in the neighbourhood of exposed tendon, bone or joints where a more vital and elastic type of covering is desirable.

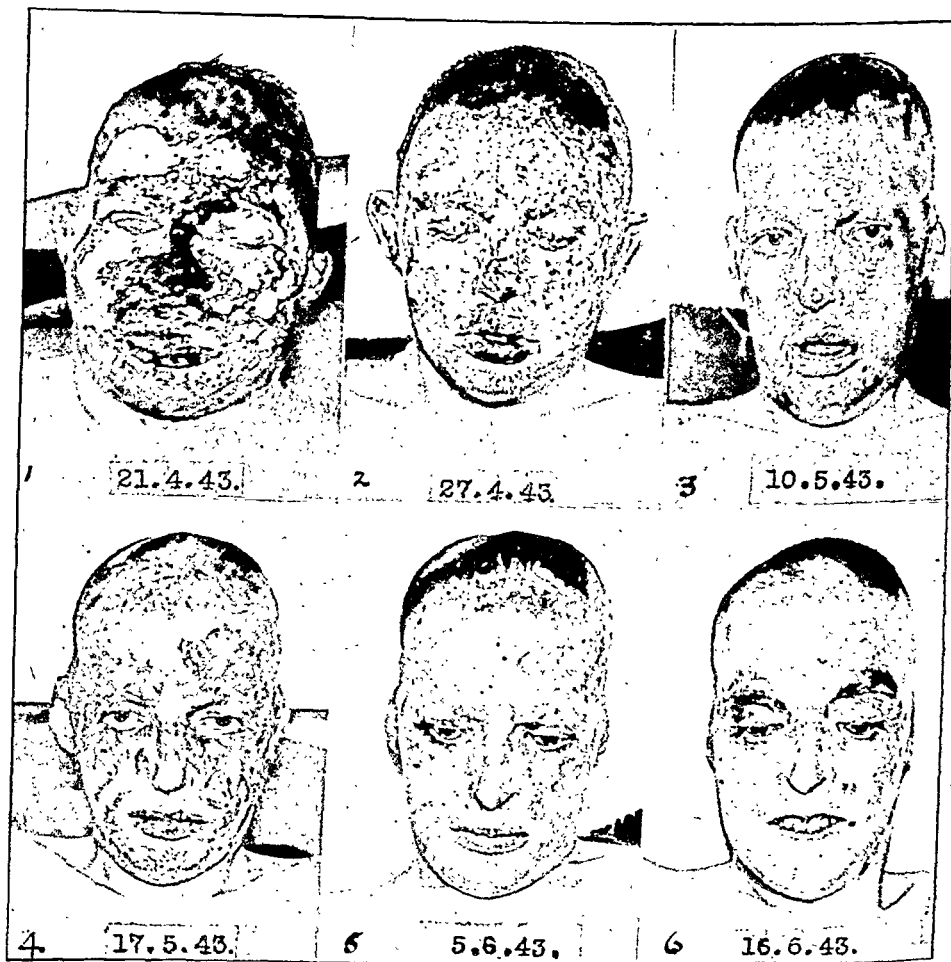


FIG. 3.—Severe 3rd degree burn of entire head.

1. 4th day. 2. 10th day: beginning ectropion both lower lids). 3. 23rd day: All sloughs removed. Now ready for split skin grafts. 4. 30th day: Good result from grafts. 5. 48th day: Head and face completely healed; marked upper and lower ectropion. 6. 59th day: Both upper lids grafted with relief of upper ectropion.

(2) "Postage stamp" grafts.—These are simply  $\frac{1}{2}$  to 1 in. squares of split skin cut with a razor arranged on a piece of tulle gras leaving gaps of  $\frac{1}{3}$  in. between squares for drainage purposes, and applied directly under pressure to the granulating surface. They combine the virtues of the small deep graft from this point of view with the advantages of the continuous sheet graft. They are not so economical of skin as the former but give a better and quicker cosmetic result. They are commonly used in burns on the backs of the hands and elsewhere where there is doubt about the take of a split skin continuous graft. Their treatment is identical with that of the small deep graft.

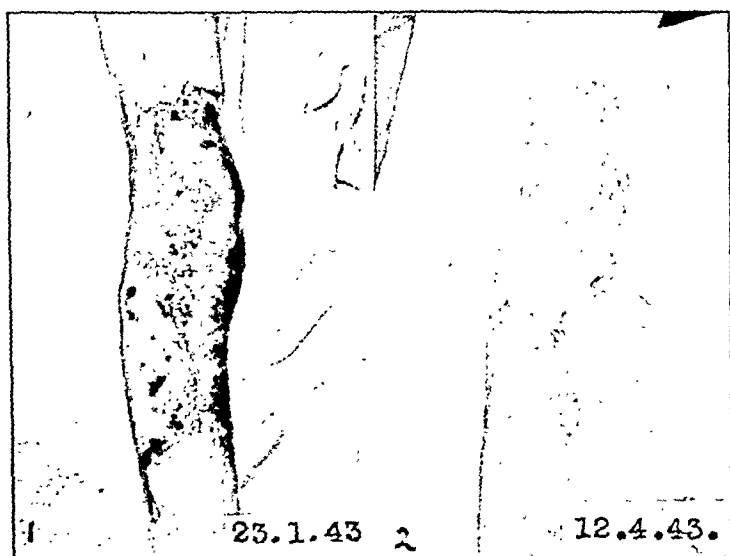


FIG. 4.—Squadron Leader W. Holdsworth's case.

1. Traumatic encircling skin loss, right leg including knee-joint. 2. Split skin grafts applied after preparation of surface. Result after three months.

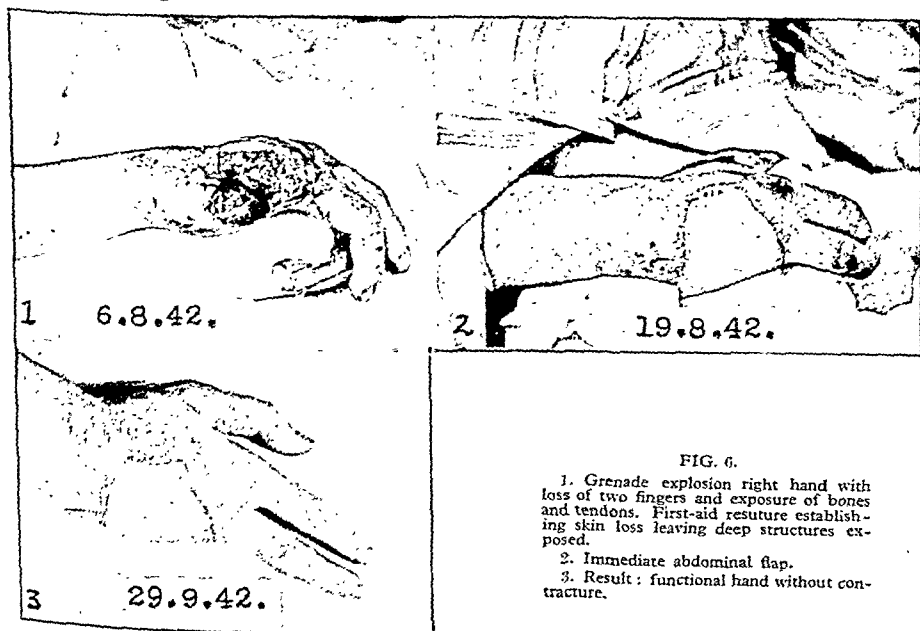


FIG. 6.

1. Grenade explosion right hand with loss of two fingers and exposure of bones and tendons. First-aid resuture establishing skin loss leaving deep structures exposed.  
2. Immediate abdominal flap.  
3. Result: functional hand without contracture.

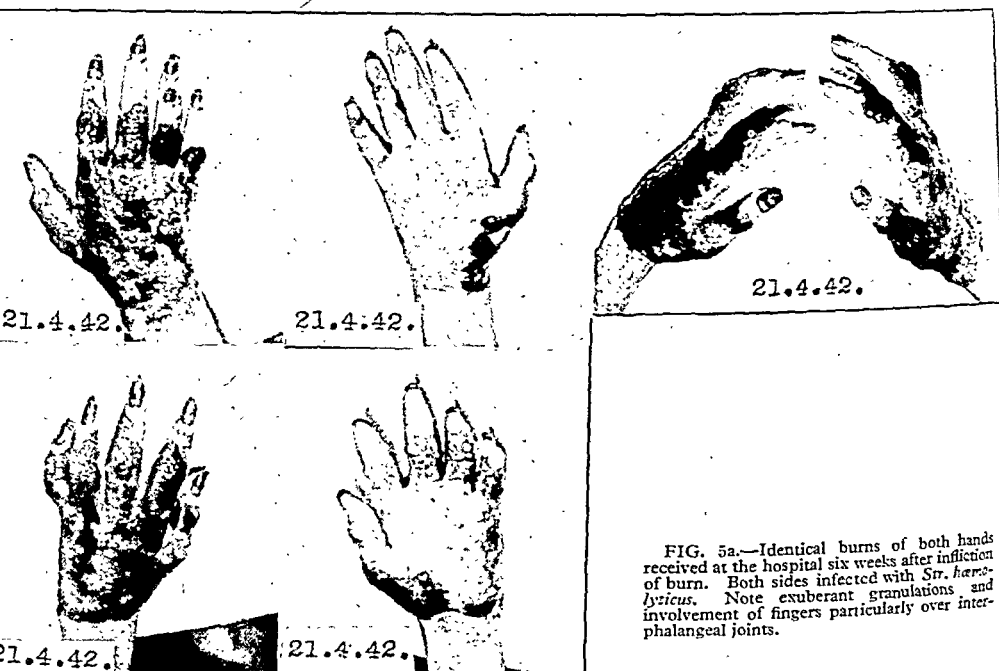


FIG. 5a.—Identical burns of both hands received at the hospital six weeks after infliction of burn. Both sides infected with *Str. haemolyticus*. Note exuberant granulations and involvement of fingers particularly over interphalangeal joints.

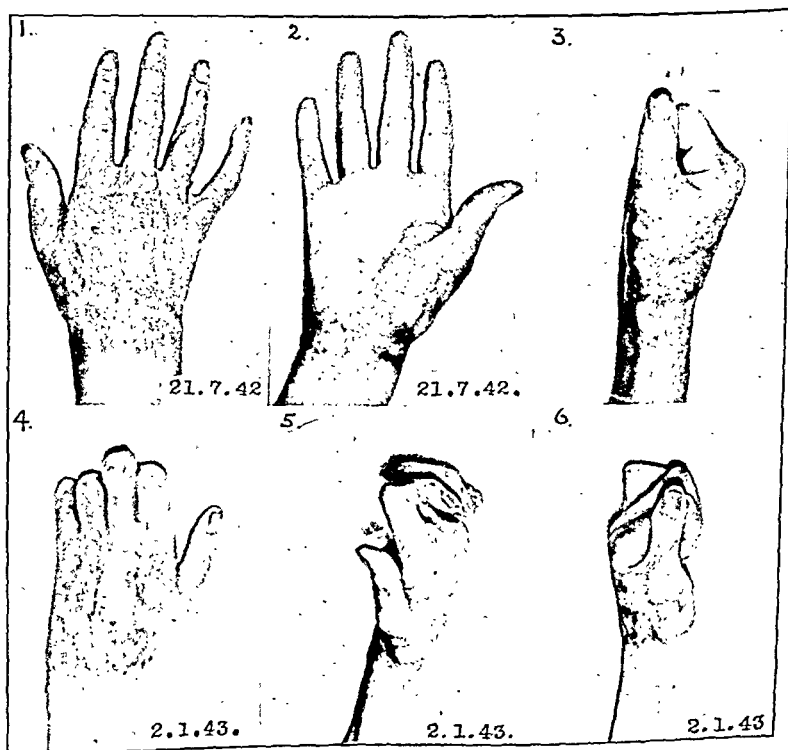


FIG. 5b.—1, 2, 3, right hand: Immediate graft after preparation of granulations, streptococcal infection still present. Graft successful—full function. 4, 5, 6, left hand: Immediate graft. Streptococcal infection still present. Complete failure. Healing slow and secondary grafts necessary. Note poor functional result in the hand.

(2) *Thin razor grafts* (Epidermal grafts).—Epidermal grafts cut from the inner side of the upper arm in a continuous sheet with a razor are almost entirely restricted in traumatic surgery to the eyelids for the relief of cicatricial ectropion. In burns in this situation they give excellent results, but in order to circumvent the severe degree of contraction to which thin grafts are liable, the defect to be grafted must be overcorrected by at least 100% (fig. 3).

(4) *Thick razor grafts* (dermo-epidermal—split skin grafts).—Wherever a continuous sheet of split skin is desirable this is the method of choice. The graft is cut freehand

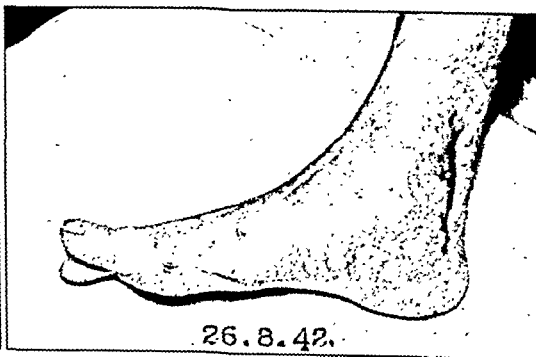
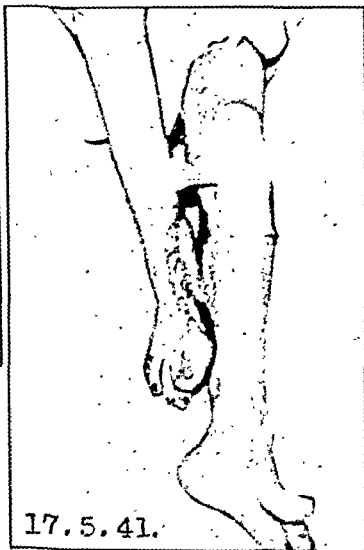
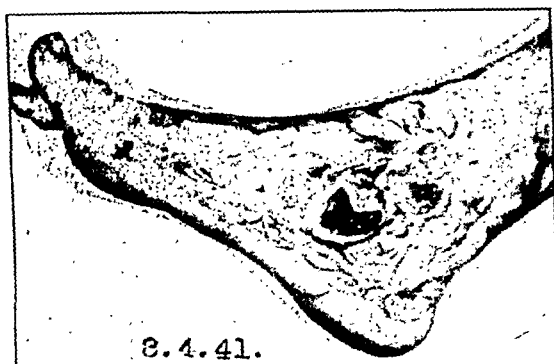


FIG. 7.—Compound fracture right ankle, with long skin inner aspect. Chronic ulceration treated by cross-leg 1; 2 from opposite calf.

with a Blair knife, a Humby razor (Humby, 1936) or more accurately by means of the Padgett dermatome (Padgett, 1939) and is applied on tulle gras under pressure to the raw surfaces, and the pressure is released after five to seven days. The graft should always be perforated with a sufficient number of stab holes to allow drainage of serum, blood or pus from beneath it, this often making all the difference between a complete loss and a complete take. It is the most satisfactory of all free grafts for the covering



of raw surfaces of moderate extent, i.e. up to 8 in. by 6 in., the larger non-functional areas being dealt with by small deep grafts. It is the method of choice in all burns of the head, face, neck and hands and in most traumatic injuries whether a plaster case is used or not (figs. 3, 4, 5a, 5b).

(5) *Pedicled flaps*.—Although these usually fall into the class of complicated reconstructural problems and their design and application are outside the scope and capability of the general or orthopaedic surgeon, they must be considered in any scheme of immediate or delayed skin coverage. Many functionally important areas, pressure points or poorly vascularized surfaces demand a more vital skin cover than that afforded by a free skin graft of any type. Exposed tendons, bones and joints require a fresh blood supply at the earliest possible moment. They must receive rather than give nourishment if they are to survive and with their survival preserve movement and function in the part. Experience shows that the use of a pedicled flap is often too long delayed and that the patient lies in hospital for months on end while unavailing efforts are made to get free grafts to take. Technically flaps are difficult to carry through and should be dealt with only by those skilled in their use. The prime indications for pedicled flaps are:

*Upper limbs*.—(a) The hands: Most explosive accidents cause more or less extensive but localized loss of parts of the hand with exposure of joints and tendons and loss of skin. The preservation of movement in what remains is of supreme importance. A vascularized skin flap is the only method of bringing blood to the devitalized part. Here a pedicled abdominal flap, preferably with a single root based on the inferior epigastric artery, is most useful (fig. 6).

(b) The wrist and elbow joints: Missile injuries of the wrist and elbow joints with skin loss should be treated initially according to the Winnett-Orr technique, followed by the application of a direct or direct delayed pedicled flap from the side.

*Lower limbs*.—(a) Compound fractures of long bones with loss of skin: As soon as the fracture is satisfactorily united the plaster should be discarded and the raw surface grafted by the quickest method. In most cases, and particularly over the tibia and fibula, free grafts are uncertain owing to the poverty of the blood supply. It is usually a waste of time to persist with them. A cross-leg or direct delayed flap from the opposite calf is the soundest method of supplying skin coverage.

(b). The foot: Avulsion of skin around the heel, plaster sores over the tendo Achillis and explosive wounds of the foot are similarly best treated by the cross-leg flap method (fig. 7). Free grafts are almost certain to fail and if they succeed often break down subsequently under the effects of pressure and weight bearing. The technique of pedicled flaps is complicated and not suitable for general use. A two- or three-stage procedure is necessary, the total time involved being six to eight weeks. The results are excellent. Only in very extensive raw surfaces are abdominal tubed pedicles required and they should be avoided whenever possible owing to the length of time taken to bring them down, the risks of circulatory loss and the acrobatic positions involved in transit.

*Comment*.—It cannot be said that there is to-day any lack of technical knowledge as to how a given raw surface should be covered with its appropriate skin rapidly and with certainty, whatever the size of the loss or the nature of the underlying lesion. Nor is there any argument as to the desirability of quick healing. It is noticeable, however, that in orthopaedic injuries insufficient attention is paid to this aspect of the lesion with the result that healing is often grossly delayed and functional results heavily compromised. There is widespread need for stronger co-operation between orthopaedic and plastic surgeon in order that the patient may receive the treatment to which he is entitled. The orthopaedic surgeon should make himself proficient in the use of the free skin graft in wound treatment. He should also be fully aware of the limitation of this method and the indications for the more complicated but often more satisfactory methods of skin replacement requiring the help of the plastic surgeon.

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## The Problem of Fractures with Associated Burn Injuries: Principles of Treatment

By Flight-Lieutenant D. C. BODENHAM, R.A.F.V.R.

In the R.A.F., this combination of major injuries is due almost exclusively to flying accidents. Beyond doubt the initial mortality is high, but once such cases reach a base hospital the recovery rate is in the order of 80%. A typical example of this combined injury is in a sergeant pilot now in the Burns Unit, who has compound fractures of the right radius and ulna, simple fracture of the right and left shafts of femur, and subluxation injury of the left knee-joint. The burns included second and third degree burn of face and neck, extensive third degree burn of both arms and forearms and both legs. His accident was in January and he is now well on the road to recovery.

### TRANSPORT OF PATIENTS AND FIRST-AID TREATMENT

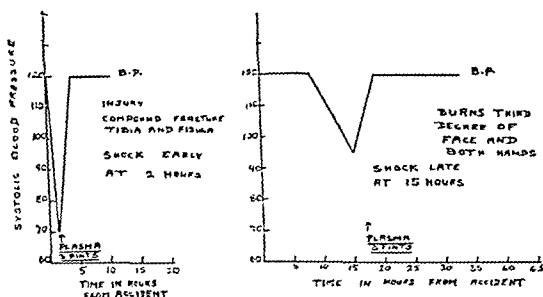
These cases should be rapidly transported to the nearest fully equipped hospital. If burns were the only injury the safe period for transfer would be up to six hours from the time of injury; with fractures and burn injuries this period is much less.

With this in mind—the best results are obtained by covering of burnt parts simply with sterile dressings. Clothes should not be removed—they have been sterilized by heat. Immobilization of the fracture is of the utmost importance; the femur is the commonest serious problem and should be placed in a Thomas's splint with traction by a well-padded clove hitch or boot clip.

### THE PROBLEM FOLLOWING ADMISSION TO HOSPITAL

*Diagnosis.*—The diagnosis of fractures in burnt patients is not easy. Such patients are often quite unaware of the extent of their injuries. The commonest fractures to be missed are those of the malar bone and maxilla, spine and foot. Complete examination and X-ray of any parts suspected are essential.

*Shock.*—The surgical shock in these cases is a complex problem (Graph 1). With

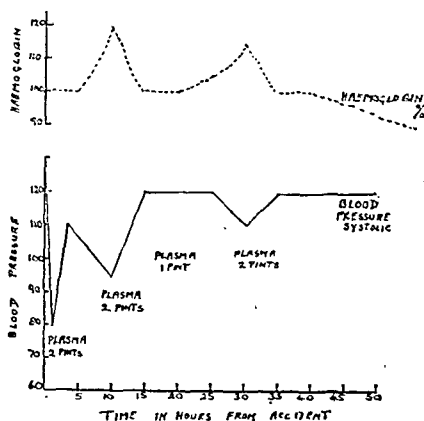


GRAPH 1.

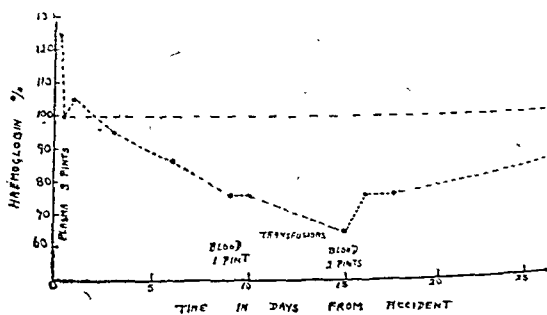
simple injuries the secondary shock is an early manifestation, the patient is transported shortly after the accident, reaching hospital an hour later with falling blood-pressure and is already in a state of shock.

A case of major burns involving 15% to 20% total body area without other injuries, will arrive in hospital six hours later with normal blood-pressure and pulse. His shock develops later—six to ten hours after the accident and may be as late as ten to twenty hours; the cause is leakage of plasma both from the surface of burns and, what is more

important, leakage into the tissues around and deep to the affected parts. The gross œdema which develops can account for many pints of fluid. This loss to the circulation causes a marked increase in blood concentration as shown by fall in blood-pressure and rise in hæmoglobin. The shock in the combination of injuries under discussion presents earlier and lasts longer than when the injuries occur alone (Graph 2).



GRAPH 2.—Combined fracture and burn injury.



GRAPH 3.—Anæmia.

**Resuscitation.**—Early and apparently successful resuscitation may be misleading and continued observation is necessary for a period of forty-eight hours. It is then improbable that further hæmoconcentration will occur. Intravenous resuscitation must be controlled by repeated blood-pressure and hæmoglobin estimations. Only by these means can the general condition be accurately assessed. Rapid pulmonary congestion and death have followed uncontrolled plasma transfusion.

Experience in this Unit of most types of fractures associated with major burns of the fractured limb as well as of the other parts has proved that such cases can be adequately treated, though it is not claimed that the best treatment for the fracture can always be associated with best treatment for the burn. Some compromise may be necessary.

Reduction by manipulation of fractured limbs which are burnt, particularly the thigh, is often a procedure associated with shock. It has been the practice in such severely injured cases to be satisfied with one manipulation and approximate reduction until with improvement in general condition it is possible, without risk, to improve position.

**Anæmia.**—At this stage the hæmolytic anæmia common to all major burns will have reduced the hæmoglobin to some 70% or less. A blood transfusion whilst the patient is under the anæsthetic is then a valuable measure. This anæmia is common to all serious injuries, but is a particular problem in these complicated cases (Graph 3). The exciting factors are: (1) Severity of initial injury and state of shock; (2) resuscitation with plasma; (3) infection of raw surfaces and wounds.

Its treatment includes maximum diet with iron, ascorbic acid and vitamin B complex in the form of yeast or marmite.

Delayed healing of burn is observed if hæmoglobin remains below 65%.

#### CARE OF THE BURNS

**Cause of death.**—The toxæmia of burns as described by Wilson and others—jaundice and fatty degeneration of the liver—is very rarely seen to-day in cases treated by the recent non-coagulation methods. This and the great strides in resuscitation, the new conception of infection and treatment by chemotherapy have assisted in reducing the mortality. Even so, the principal cause of death in extensive burns after the fourth day is widespread surface infection. This can be reduced by (a) Early covering of burnt surfaces with sterile dressings. (b) Early transport to Specialist Hospital. (c) Adequate cleansing and dressing of burnt surfaces.

Thorough cleansing of the fresh burn can be carried out painlessly without general anæsthesia after a dose of morphia gr.  $\frac{1}{4}$  to  $\frac{1}{3}$ . Deep burns are quite insensitive,

owing to destruction of nerve endings. The new synthetic detergent, cetyl trimethyl ammonium bromide (Barnes, 1942, *Lancet* (i), 531), used as the cleansing agent in 1% aqueous solution is most satisfactory and when so used will materially reduce the incidence of surface infection.

By such methods patients who are too ill to take a general anaesthetic may without being moved to the operating theatre receive effective local treatment before infection can develop. All fresh burnt surfaces must be considered contaminated and so treated. Following the cleansing, the part is lightly "frosted" with sulphonamide powder and dressed with tulle gras, gauze and bandage. Firm pressure as advocated by Koch in America and others, will in conjunction with elevation of the injured part reduce the fluid loss and prevent excessive swelling. In cases of extensive burns only a part of the total area should be exposed at a time; then with the utmost gentleness the least effect on the general condition is produced.

**Immobilization.**—Manipulation of a fractured limb which is also burnt must be postponed until the latter has received this treatment. If the decision is made to plaster the limb then the dressings should be thin. A heavily padded plaster defeats its own purpose.

The immobilization of each case is a problem itself. The exact method will depend on the combined experience of the orthopaedic and plastic surgeons.

In the case of the femur the choice is traction with removable dressings for local therapy. This gives the most rapid healing for all burns.

Pins must not be put through burnt areas for fear of bone infection. Therefore immobilization in plaster is necessary as it is in the case of most other fractures.

With cases treated in plaster care must be taken that dressings are not so occlusive that if infection develops pus cannot escape. An artificial abscess cavity will make change of plaster at an early date essential whereas with free drainage it could have been avoided. It is worth noting that home-made plaster bandages are more absorbent than proprietary plaster bandages.

#### INFECTION

At every change of burn or wound dressing a swab should be taken for culture and the appropriate local treatment given. The following methods are successful in this unit:

INFECTION	TREATMENT
<i>Str. hæmolyticus.</i>	Sulphanilamide powder applied as a light frosting, every 24 or 48 hours
Sulphonamide-resistant <i>H. streptococcus.</i>	Penicillin in lanette wax and vaseline emulsion cream—strength 100 units per gramme applied every 24 or 48 hours
<i>Staphylococcus aureus</i> <i>B. pyocyaneus</i>	Penicillin as above Sulphacetamide powder

Penicillin is beyond doubt the most effective agent yet produced for this purpose. It is at least 50 times more effective than sulphonamide. It is quite non-toxic. This is amply proved in 100 cases treated in this Unit.

#### CHEMOTHERAPY

**Local.**—The use of sulphanilamide as a local application to extensive raw areas is not without risk. In one case of third degree granulating burns of both legs a blood level of 15 mg. % was recorded on account of rapid absorption. The less soluble sulphathiazole is safer in such cases.

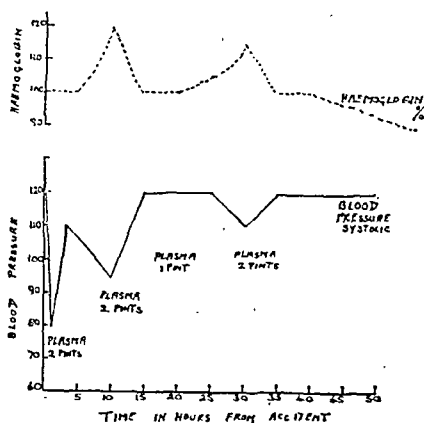
**General.**—It is considered justifiable to give severe cases of burns a course of a sulphonamide if infection of the injuries has begun to produce deterioration of general condition. It is not given as a routine to all patients, nor would experience justify it. The choice is sulphathiazole, given by mouth in doses of 2 g. stat. and 1 g. four-hourly up to 20 g.

**Fluid balance.**—The keeping of a fluid balance chart during the seven days following the accident is essential. An intake of 120 oz. per day should be aimed at with a minimum urine output of 60 oz.

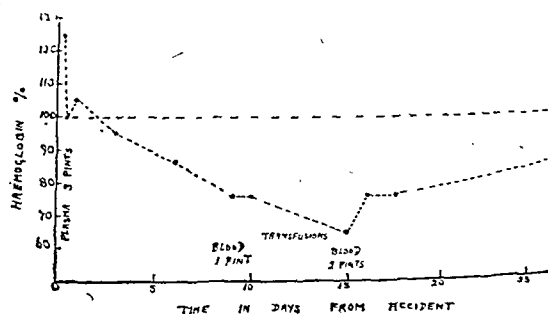
**Vomiting in burns** is very rare. It has not been a problem in any of the first 100 cases of major burns treated in this Unit.

**Fourth week, healing.**—The aim is grafting of third degree burns as soon as possible.

important, leakage into the tissues around and deep to the affected parts. The gross œdema which develops can account for many pints of fluid. This loss to the circulation causes a marked increase in blood concentration as shown by fall in blood-pressure and rise in hæmoglobin. The shock in the combination of injuries under discussion presents earlier and lasts longer than when the injuries occur alone (Graph 2).



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Thorough cleansing of the fresh burn can be carried out painlessly without general anæsthesia after a dose of morphia gr.  $\frac{1}{4}$  to  $\frac{1}{5}$ . Deep burns are quite insensitive.



FIG. 4.—The area to be grafted at three and a half weeks.



FIG. 5.—The combined sheet of graft squares and tulle gras is laid against the granulations.

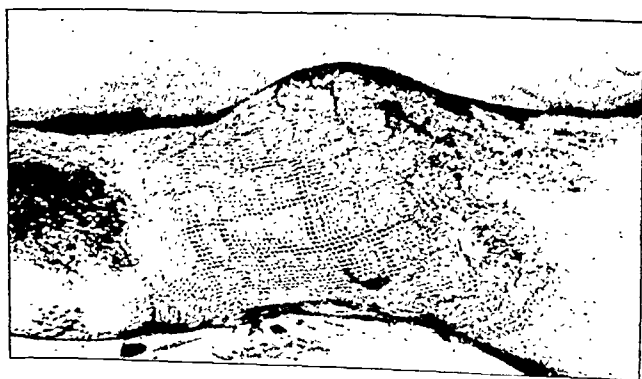


FIG. 6.—The sheet is anchored with sutures at each corner and covered with pressure dressing of gauze, absorbent wool and elastic crepe bandage.



FIG. 1.—A split skin graft is taken from the inner side of thigh. The graft is laid out flat on a piece of tulle gras.

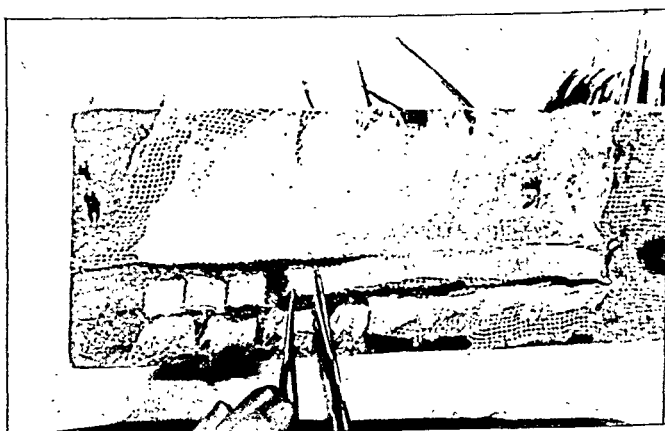


FIG. 2.—The graft and tulle gras are cut into small squares.

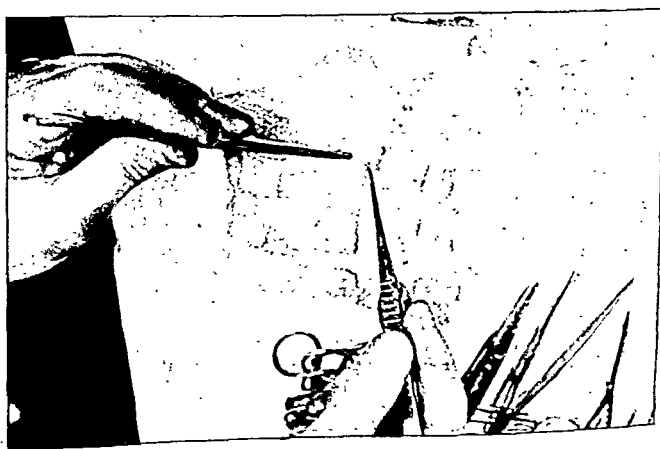


FIG. 3.—The squares are laid on a second piece of tulle gras cut to the size of the area to be grafted (fig. 4).

## Air Arthrography in the Diagnosis of Internal Derangement of Knee-Joint

By Flight Lieutenant E. W. SOMERVILLE, R.A.F.V.R.

AIR arthrography in the diagnosis of internal derangement of knee-joints has been used sporadically for some years but has never been widely accepted owing to the absence of a standard technique and the difficulty in the interpretation of the radiographs. Recently Cullen and Chance in a review of 32 patients examined in this way reported a high percentage of correct diagnoses subsequently confirmed by arthrotomy (*Brit. J. Surg.*, 1943, 30, 241).

In the present series, 30 patients were examined in two and a half months. There was no particular selection. All those suspected of having an internal derangement of the knee-joint were examined by air arthrography. Some had obviously torn cartilages, others were less obvious and some very doubtful.

The technique employed was based upon that described by Cullen and Chance. The leg received a twenty-four-hour skin preparation, the knee was then filled with air which had previously been passed through a cotton-wool filter. Air was injected until there was very definite positive pressure in the joint. The amount required varied from 80 to 120 c.c. A firm bandage was applied above the knee to empty the suprapatellar pouch as far as possible and three glancing views of each cartilage were taken to show the anterior, middle and posterior portions and finally, a lateral view through the back of the knee-joint with the knee in full flexion. In order to obtain satisfactory views the X-ray tube must be centred exactly over the joint and the side of the joint being examined must be opened up as far as possible. This was done by forcibly abducting or adducting the tibia on the femur with the knee slightly flexed over a curved cassette while the radiograph was being taken. A 12 in. sinus cone was used kV. 50, ma. 60. Time of exposure 0.4 sec.

Of the 30 knees examined 21 came to operation and in the remaining 9 no lesion was found on arthrography and clinically they were very doubtful.

Of the 21 which came to operation the arthrograms of 3 of them were useless owing to the presence of fluid in the joint which obscured the cartilages. In the remaining 18 the findings at operation confirmed the arthrography findings though in 3 cases the exact type of lesion was not diagnosed prior to arthrotomy. In 15 cases the exact lesion could be diagnosed from the arthrogram without difficulty. Reactions were seen in 8 knees. They were slight in 6 and consisted of a synovial effusion. Moderately severe in 2 with pain for twenty-four hours and effusion. Every reaction cleared up within a few days. In each of these knees a synovial effusion was present before the arthrogram was done. This appears to be a definite factor in the causation of reactions.

Some slight discomfort was complained of by the more apprehensive patients but the more phlegmatic ones had no symptoms.

The following slides were shown:

- (1) Normal medial cartilage (fig. 1).
- (2) Normal lateral cartilage, anterior part (fig. 2).
- (3) Normal lateral cartilage, posterior part (fig. 3).
- (4) Normal medial cartilage, posterior part with knee fully flexed.
- (5) Knee fully flexed, posterior horn, medial cartilage detached from tibia (fig. 4).
- (6) Bucket handle medial cartilage (fig. 5).
- (7) Bucket handle tear, secondary split in peripheral rim.
- (8) Posterior horn tear without displacement (fig. 6).
- (9) Very small posterior horn tear (fig. 7).
- (10) Peripheral detachment of cartilage, medial (fig. 8).
- (11) Peripheral detachment of cartilage, lateral.
- (12) Small cartilage tear and loose body.

Thus a variety of cartilage lesions can be demonstrated by air arthrography. In the present series 18 positive diagnoses were made by arthrography and proved by arthrotomy. How many of the negative arthrographies were correct it is impossible to say yet, but in 5 negative arthrographies the knees were explored because of strong clinical evidence, and no lesion was found.

To summarize: These figures confirm (1) that lesions of menisci can be demonstrated by arthrography, and (2) that a negative arthrogram throws doubt on the validity of a positive clinical diagnosis. In such circumstances operation should be avoided until the knee has been given a further trial.



By the fourth week the sloughs should have separated and granulation be fit to receive the grafts. Second degree burns unless heavily infected are never a problem at this stage—they are always healed.

Control of surface infection by local sulphonamides or penicillin prior to grafting is the treatment of choice at this stage, but may not be possible owing to the fractures.

*Healing.*—There is no question that the healing of epithelium is slower under plaster in the presence of infection. Successful grafting under plaster in the absence of infection is a valuable measure. In the presence of infection local treatment through a window in the plaster for at least a week is probably necessary, and then curettage of the granulations prior to grafting will give good results.

*Grafts.*—The use of sheet grafts on these cases is frequently most disappointing. The multiple or pinch-type of graft is to be preferred. The most rapid method of grafting any extensive area and a method which has been used successfully in this Unit for over eighteen months is to cut a sheet graft (fig. 1), and divide this into small pieces (fig. 2). If the graft is laid on tulle gras, this is easily handled—the small squares of graft ( $\frac{1}{4}$  in. square) are stuck to it, and laid on a large piece of tulle gras the size of the wound

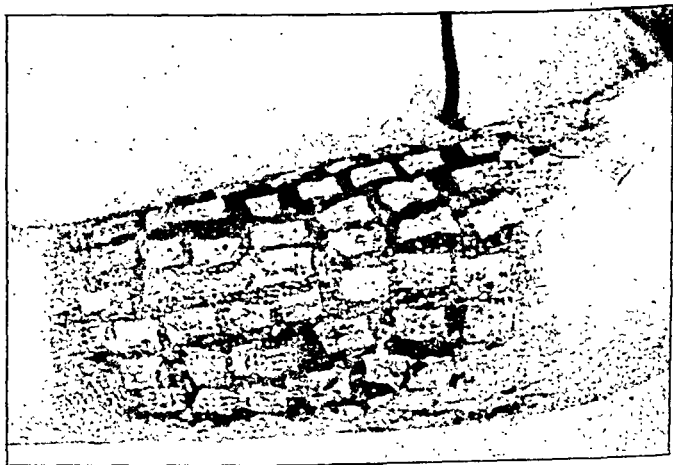


FIG. 7.—A larger area treated in the same way. Fourth day after operation. This had healed completely five days later.

(fig. 3). The whole is applied to the granulating surface and such a technique offers a high rate of success (figs. 4, 5 and 6).

If the grafts are applied at distances of one-fifth inch apart, the whole area will be healed within ten days under normal conditions (fig. 7).

Long delayed healing in burns is almost a disaster. A vast thickness of tough fibrous tissue is laid down in horizontal sheets, strangulating the few blood-vessels that penetrate it, and as the fibrous tissue matures contracture occurs. Planes of tension are set up splinting the joints and limiting movement.

Epithelialization is long delayed and when it occurs it is thin and delicate. Cracks and fissures develop.

Areas which are skin grafted during the fourth or fifth week never present these problems.

POSTSCRIPT.—Since this article was written a similar method has been described by Gabarro (*Brit. med. J.*, 1943, i, 723). The principle of multiple small grafts is not new and was described twenty years ago by Steele and others. It is pointed out that the Author advises placing the grafts more closely than Gabarro.

D. C. B.

## Contractures of Fingers and Toes After War Wounds

By Flight-Lieutenant C. M. SQUIRE, R.A.F.V.R.

I PROPOSE to emphasize the common preventable deformities; to discuss the methods we use in an attempt to prevent them, and their treatment when they do arise.

The causes of digital contracture are: Muscle spasm; soft tissue damage; injuries to tendon, muscle and nerve; joint and bone injuries. All of these, of course, augmented by the associated pain on movement, and possibly complicated by wounds; particularly if these wounds are infected, leading to the matting together of muscles and tendons with fibrous tissue. Then, of course, there is the effect of gravity, particularly in the toes; and, a separate entity but often associated with this, prolonged swelling of digits.

*Prevention.*—First: By the effective treatment of the local causes. Relief of muscle spasm by adequate immobilization; proper surgical treatment of wounds; and all possible measures to combat infection, particularly free drainage; correct posture, again immobilization, and full use of skin grafting. The early and accurate reduction of dislocations and fractures, and careful assessment of the state of healing at which mobilization can safely be commenced; elevation of the limb in the early stages of injury and later the avoidance of prolonged dependency in severe or infected injuries.

As a corollary to all these, correct general plaster or splinting technique. Inadequate immobilization is useless. Unnecessary over-splinting will impede activity; while incorrect position leads to the worst of deformities.

Second—and this is the very key locking the door on preventable contractures—by determined, sustained, and very frequent active movements of all digital joints as soon after injury as local or general condition permits. It must be remembered that many contractures *do* occur when there is no warrantable predisposing cause at all. Whatever the contributory factors the cause is neglect—neglect of exercise.

Third: Active movement in all directions cannot always be performed. In such cases each uncontrolled joint should be put through as complete a range of passive movement as possible without pain, or without strong resistance if there is no sensation, twice a day.

But, it is impossible to over-emphasize that it is the *active* exercise that is all-important. Occupational therapy for the toes would be a fine innovation, even if the standard of needlework did fall!

One of the most important duties of our trained Rehabilitation Orderlies is to see that no avoidable digital contracture occurs. They are taught to ensure that for five minutes of every hour of the day, every suitable patient shall perform active exercises appropriate to his condition; and in each case, on each occasion, full digital exercises are included. A trained Sister can supervise these exercises as long as the enlightened and keen co-operation of the patient is obtained.

Finally: Splinting in the prevention of contractures is necessary where active muscle power is unable to maintain a neutral position. Splinting in digital conditions should aid weak and inactive muscles to maintain joint equilibrium. It should only be a corollary—it should never impede active, or permanently occlude passive movement. It is just as wrong to hinder active toe flexion by a toe platform on a plaster cast as it is to prevent active finger flexion by some rigid splinting.

*Types.*—What are the more common preventable digital contractures?

To mention a few: There is the typical "claw" hand or foot due to over-action of the long flexors and extensors, and to intrinsic muscle weakness; so prone to occur in ill-treated burns of the hand. There are the fixed extended fingers and toes due to rigid splinting in malposition. Both these deformities are of such tragic significance in the hand. Then there are the fixed flexion contractures, such a hindrance to subsequent motility when they occur in the toes.



FIG. 1.

FIG. 2.

FIG. 3.

FIG. 1.—Normal medial cartilage.

FIG. 2.—Normal lateral cartilage anterior end.

FIG. 3.—Normal lateral cartilage, posterior part. Popliteal sheath filled with air (A).

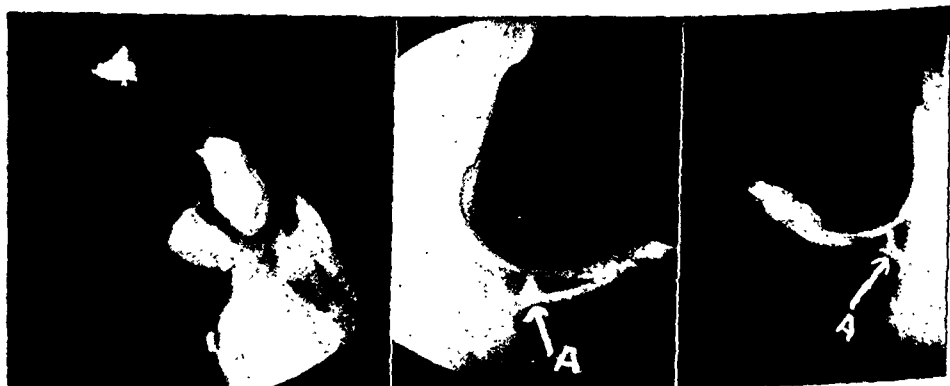


FIG. 4.

FIG. 8.

FIG. 9.

FIG. 4.—Lateral view; knee fully flexed. Cartilage seen drawn out of back of joint.

Posterior horn detachment from tibia. Medial.

FIG. 8.—Shows peripheral separation, medial cartilage.

FIG. 9.—Shows split in posterior part of medial cartilage at (A).

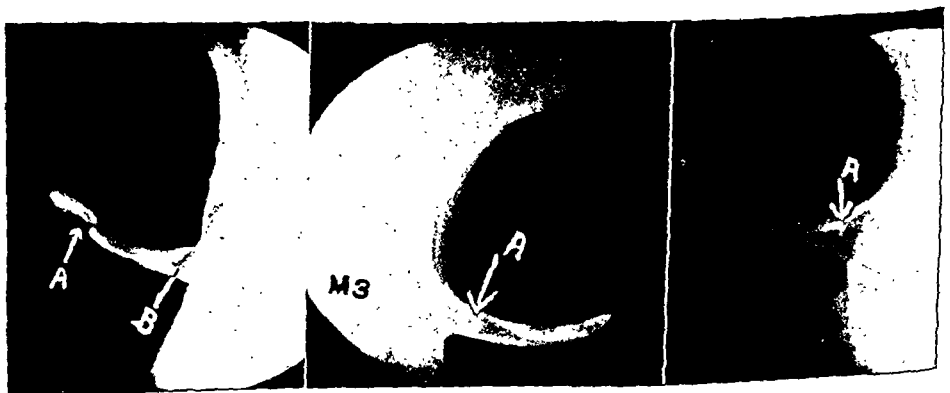


FIG. 5.

FIG. 7.

FIG. 6.

FIG. 5.—Shows typical bucket handle tear, medial meniscus. (A) Bucket handle; (B) Outer rim.

FIG. 7.—Small posterior horn tear. Medial cartilage.

FIG. 6.—Small posterior horn tear. No separation. Medial cartilage.

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*Treatment.*—The aim of treatment is maximum function within the most useful range of movement.

Active exercise is of paramount importance. Every muscle that can actively be used must be made to exert its maximum contraction in sustained efforts at frequent intervals. The duty of the Rehabilitation Orderly is now to make sure that recovery by exercise shall progress as far as is possible.

The premises for passive movement also of course hold good.

Finally, what of the splint? We feel that the detachable flexible type of splint is almost always preferable. We do use rigid splints where necessary; usually closely moulded plaster slabs padded with felt and strapped in position. Such splints do prevent further deformity and when well applied can diminish it. But if constantly used they lead to stiffness and lack of tone in active muscles.

We use detachable splints which exert a low tension, adjustable elastic pull against the particular deformity, and at the same time permit and encourage a full range of active movements, aiding the weaker and inactive muscles to resist their more powerful opponents and maintain a balanced joint posture.

We have found them of great benefit and very useful accessories in preventive treatment.

*Conclusion.*—These devices are submitted as a useful adjunct in the treatment of contractures and of such joint imbalance as is likely to lead to contractures, or at any rate stiffness if rigid splinting is employed.

I would like to reiterate the two paramount principles in preventing digital deformities: the daily full passive range of all digital joint movements, and, most important, the acquisition in all patients of a toe and finger "conscience"—the conscience of the urgency of determined, repeated, unlimited active exercise of all their fingers and all their toes.

# INDEX

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